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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XIX.—FROM CREATION TO EVOLUTION.

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PART II.

THEOLOGICAL TEACHINGS REGARDING THE ANIMALS AND MAN.

IN one of the windows of the cathedral at Ulm a mediæval glass-stainer has represented the Almighty as engaged in creating the animals, and there has just left the divine hands an elephant fully accoutered, with armor, harness, and housings—ready for war. Similar representations appear in illuminated manuscripts and even in early printed books, and, as the culmination of the whole, the Almighty is shown as extracting, with evident effort, the first woman from the side of the first man.

This view of the general process of creation had come from far; it appeared under varying forms in various ancient cosmogonies, and, passing into our own sacred books, became the starting point of a vast new development of theology.

The fathers of the Church generally received each of the two accounts of creation in Genesis literally, and then, having done their best to reconcile them with each other and to mold them together, made them the final test of thought upon the universe and all things therein. At the beginning of the fourth century Lactantius struck the keynote of this mode of subordinating all other things in the study of creation to the literal text of Scripture, and he enforces his view of the creation of man by a bit of philology, saying the final being created "is called man because he is made from the ground—*homo ex humo.*"

In the second half of the same century this view as to the literal acceptance of the sacred text was reasserted by St. Ambrose, who, in his work on the creation, declared that "Moses opened his mouth and poured forth what God had said to him." But a greater than either of them fastened this idea into the Christian theologies. St. Augustine, preparing his Commentary on the Book of Genesis, laid down in one famous sentence the law which has lasted in the Church until our own time: "Nothing is to be accepted save on the authority of Scripture, since greater is that authority than all the powers of the human mind." The vigor of the sentence in its original Latin carried it ringing down the centuries: "Major est Scripturæ auctoritas quam omnis humani ingenii capacitas."

Through the mediæval period, in spite of a revolt led by no other than St. Augustine himself, and followed by a series of influential churchmen, contending, as we shall hereafter see, for a modification of the accepted view of creation, this phrase held the minds of men firmly. The great Dominican encyclopedist, Vincent of Beauvais, in his Mirror of Nature, while mixing ideas brought from Aristotle with a theory drawn from the Bible, stood firmly by the first of the accounts given in Genesis, and assigned the special virtue of the number six as a reason why all things were created in six days; and in the later middle ages that eminent authority, Cardinal d'Ailly, accepted in a general way everything regarding creation in the sacred books as written. Only a faint dissent is seen in Gregory Reisch, another authority of this later period, who, while giving in his book on the beginning of things a full-length woodcut showing the Almighty in the act of extracting Eve from Adam's side, with all the rest of new-formed Nature in the background, leans in his writings, like St. Augustine, toward a belief in the pre-existence of matter.

At the Reformation the vast authority of Luther was thrown in favor of the literal acceptance of Scripture as the source of natural science; the allegorical and mystical interpretations of earlier theologians he utterly rejected. "Why," he asks, "should Moses use allegory when he is not speaking of allegorical creatures or of an allegorical world, but of real creatures and of a visible world, which can be seen, felt, and grasped? Moses calls things by their right names, as we ought to do. . . . I hold that the animals took their being at once upon the word of God, as did also the fishes in the sea."

Not less explicit in his adherence to the literal account of creation given in Genesis was Calvin. He warns those who, by taking another view than his own, "basely insult the Creator, to expect a judge who will annihilate them." He insists that all species of animals were created in six days, each made up of an

evening and a morning, and that no new species has ever appeared since. He dwells on the production of birds from the water as resting upon certain warrant of Scripture, but adds, "If the question is to be argued on physical grounds, we know that water is more akin to air than the earth is." As to difficulties in the scriptural account of creation, he tells us that God "wished by these to give proofs of his power which should fill us with astonishment."

The controlling minds in the Roman Catholic Church steadfastly held this view. In the seventeenth century Bossuet threw his vast authority in its favor, and in his Discourse on Universal History, which has remained the foundation not only of theological but of general historical teaching in France down to the present republic, we find him calling attention to what he regards as the culminating act of creation, and asserting that, literally, for the creation of man earth was used, and "the finger of God applied to corruptible matter."

Protestant Europe held this idea no less persistently. In the seventeenth century Dr. John Lightfoot, Vice-Chancellor of the University of Cambridge, the great rabbinical scholar of his time, attempted to reconcile the two accounts in Genesis by saying that of the "clean sort of beasts there were seven of every kind created, three couples for breeding and the odd one for Adam's sacrifice on his fall, which God foresaw"; that of unclean beasts only one couple was created; and finally, that "heaven and earth, center and circumference, were created all together, in the same instant, and clouds full of water," and that "this work took place and man was created by the Trinity on October 23, 4004 B. C., at nine o'clock in the morning." Here was, indeed, a triumph of Lactantius's method, the result of a thousand years of biblical study and theological thought since Bede, in the eighth century, and Vincent de Beauvais, in the thirteenth, had declared that creation must have taken place in the spring. Yet, alas! within two centuries after Lightfoot's great theological demonstration as to the exact hour of creation, it was discovered that at that hour an exceedingly cultivated people, enjoying all the fruits of a highly developed civilization, had long been swarming in the great cities of Egypt, and that other nations hardly less advanced had at that time reached a high development in Asia.

So literal was this whole conception of the work of creation that in these days it can scarcely be imagined. The Almighty was represented in theological literature, in the illustrations of Bibles, and in works of art generally, as a sort of enlarged and venerable Nuremberg toymaker; a pictorial representation in accordance with the well-known sacred account, showing the Creator in the act of sewing skins of beasts into coats for Adam and

Eve, presented no difficulties to the docile minds of the middle ages and Reformation period; hence it was that, when the discovery of fossils began to provoke thought, these were declared to be "models of his works approved or rejected by the great Artificer, outlines of future creations, sports of Nature," or "objects placed in the strata to bring to naught human curiosity"; and this kind of explanation lingered on until in our own time that excellent naturalist, Mr. Gosse, in his anxiety to save the literal account in Genesis, has urged that Jehovah tilted and twisted the strata, scattered the fossils through them, scratched the glacial furrows upon them, spread over them the marks of erosion by water, and set Niagara pouring all in an instant, thus mystifying the world "for some inscrutable purpose, but for his own glory."*

The next important development of theological reasoning had regard to the *divisions* of the animal kingdom.

Naturally, one of the first divisions which struck the inquiring mind was that between useful and noxious creatures, and the question therefore occurred, How could a good God create tigers and serpents, thorns and thistles? The answer was found in theological considerations upon sin: To man's first disobedience all woes were due. Great men for eighteen hundred years developed the theory that before Adam's disobedience there was no death, and therefore neither ferocity nor venom.

Some typical utterances in the evolution of this doctrine are worthy of a passing glance. St. Augustine expressly confirmed and emphasized the view that the vegetable as well as the animal kingdom was cursed on account of man's sin. Two hundred years later this utterance had been echoed on from father to father of the Church until it was caught by Bede; he declared that before man's fall animals were harmless, but became poisonous or hurtful on account of sin, and he said, "Thus fierce and poisonous animals were created for terrifying man, because God foresaw that he would sin, in order that he might be made aware of the final punishment of hell."

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* For the citation from Lactantius, see Divin. Instit., lib. ii, cap. xi, in Migne, tome vi, pp. 311, 312; for St. Augustine's great phrase, see the De Genes. ad lift., ii, 5; for St. Ambrose, see lib. i, cap. ii; for Vincent de Beauvais, see the Speculum Naturale, lib. i, cap. ii, and lib. ii, cap. xv and xxx; also Bourgeat, Études sur Vincent de Beauvais, Paris, 1856, especially chaps. vii, xii, and xvi; for Cardinal d'Ailly, see the Imago Mundi, and for Reisch, see the various editions of the Margarita Philosophica; for Luther's statements, see Luther's Schriften, ed. Walch, Halle, 1740, Commentary on Genesis, vol. i; for Calvin's view of the creation of the animals, including the immutability of species, see the Comm. in Gen., tome i of his Opera omnia, Amst., 1671, cap. i, v. xx, p. 5, also cap. ii, v. ii, p. 8, and elsewhere; for Bossuet, see his Discours sur l'Histoire universelle, Œuvres de Bossuet, tome v, Paris, 1846; for Lightfoot, see his works, edited by Pitman, London, 1822; for Bede, see the Hexæmeron, lib. i, in Migne, tome xci, p. 21.

In the twelfth century this view was incorporated by Peter Lombard into his great theological work of the Sentences, which became the text-book of theology through the middle ages. He affirmed that "no created things would have been hurtful to man had he not sinned; they became hurtful for the sake of terrifying and punishing vice or of proving and perfecting virtue; they were created harmless, and on account of sin became hurtful."

This theological theory regarding animals was brought out in the eighteenth century with great force by John Wesley. He declared that before Adam's sin "none of these attempted to devour or in any wise hurt one another"; "the spider was as harmless as the fly, and did not lie in wait for blood." Not only Wesley, but the eminent Dr. Adam Clarke and Dr. Richard Watson, whose ideas had the very greatest weight among the English Dissenters, and even among leading thinkers in the Established Church, held firmly to this theory. Not until, in our own time, geology revealed the remains of vast multitudes of carnivorous creatures, many of them with half-digested remains of other creatures in their stomachs, all extinct long ages before the appearance of man upon earth, was a victory won by science over theology in this field.

A curious development of this doctrine was seen in the belief drawn by sundry old commentators from the condemnation of the serpent in Genesis—a belief, indeed, perfectly natural, since it was evidently that of the original writers of the account preserved in the first of our sacred books. This belief was that, until the tempting serpent was cursed by the Almighty, all serpents stood erect, walked, and talked.

This belief was handed down the ages as part of "the sacred deposit of the faith" until Watson, the most prolific writer of the great evangelical reform in the eighteenth century and the standard theologian of the evangelical party, declared: "We have no reason at all to believe that the animal had a serpentine form in any mode or degree until its transformation; that he was then degraded to a reptile to go upon his belly imports, on the contrary, an entire loss and alteration of the original form." Here, again, was a ripe result of the theologic method diligently pursued by the strongest thinkers in the Church during nearly two thousand years; but this "sacred deposit" also faded away when the geologists found abundant remains of fossil serpents dating from periods long before the appearance of man.

Yet more troublesome questions arose among theologians regarding animals classed as "superfluous." St. Augustine was especially exercised thereby. He says: "I confess I am ignorant why mice and frogs were created, or flies and worms. . . . All creatures are either useful, hurtful, or superfluous to us. . . . As

for the hurtful creatures, we are either punished, or disciplined, or terrified by them, so that we may not cherish and love this life." As to the "superfluous animals," he says, "Although they are not necessary for our service, yet the whole design of the universe is thereby completed and finished." Luther, who followed St. Augustine in so many other matters, declined to follow him fully in this. To him a fly was not merely superfluous, it was noxious—sent by the devil, and perhaps possessed by the devil, to trouble him when reading.

Another subject which gave rise to much searching of the Scriptures and long trains of theological reasoning, was the difference between the creation of man and that of other living beings.

Great stress was laid by theologians from St. Basil and St. Augustine to St. Thomas Aquinas and Bossuet, and from Luther to Wesley, on the radical distinction indicated in Genesis, God having created man "in his own image"; what this statement meant was seen in the light of the later biblical statement that "Adam begat Seth in his own likeness, after his image."

In view of this and well-known texts incorporated from older creation legends into the Hebrew sacred books it came to be widely held that, while man was directly molded and fashioned separately by the Creator's hand, the animals generally were evoked in numbers from the earth and sea by the Creator's voice.

A question now arose naturally as to the *distinctions of species* among animals. The vast majority of theologians agreed in representing all animals as created "in the beginning," and named by Adam, preserved in the ark, and continued ever afterward under exactly the same species. Some difficulties arose here and there as zoölogy progressed and revealed ever-increasing numbers of species; but through the middle ages, and indeed long after the Reformation, this difficulty was easily surmounted: by making the ark of Noah larger and larger, and especially by holding that there had been a human error in regard to the unit of measurement for the ark, all difficulty was at first avoided.*

But naturally there was developed among both ecclesiastics and laymen a human desire to go beyond these special points in the history of animated beings—a desire to know what the creation really is.

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* For St. Augustine, see De Genesi and De Trinitate, *passim*; for Bede, see Hexæmeron, lib. i, in Migne, tome xci, pp. 21, 36–38, 42; and De Sex Dierum Creatione, in Migne, tome. xciii, p. 215; for Peter Lombard on "noxious animals," see his Sententiæ, lib ii, dist. xv, 3, Migne, tome cxcii, p. 682; for Wesley, Clarke, and Watson, see quotations from them and notes thereto in my chapter on Geology; for St. Augustine on "superfluous animals," see the De Genesi, lib. i, cap. xvi, 26; on Luther's view of flies, see the Table Talk and his famous utterance, "Odio muscas quia sunt imagines diaboli et hæreticorum."

Current legends, stories, and travelers' observations, poor as they were, tended powerfully to stimulate curiosity in this field.

Three centuries before the Christian era Aristotle had made the first really great attempt to satisfy this curiosity; he had begun a development of studies in natural history which remains one of the greatest achievements in the story of our race.

But the feeling which we have already seen so strong in the early Church—that all study of Nature was futile in view of the approaching end of the world, indicated so clearly in the New Testament and voiced so powerfully by Lactantius and St. Augustine—held back this current of thought for many centuries. Still, the better tendency in humanity continued to assert itself. There was indeed an influence coming from the Hebrew Scriptures themselves which wrought powerfully to this end. In spite of all that Lactantius or St. Augustine might say as to the futility of any study of Nature, the grand utterances in the Psalms regarding the beauties and wonders of creation, in all the glow of the truest poetry, ennobled the study even among those whom logic drew away from it.

But, as a matter of course, in the early Church and throughout the middle ages all such studies were cast in a theologic mold. Without some purpose of biblical illustration or spiritual edification they were considered futile; too much prying into the secrets of Nature was very generally held to be dangerous both to body and soul; only for showing forth God's glory and his purposes in the creation were such studies praiseworthy. The great work of Aristotle was under eclipse. The early Christian thinkers gave little attention to it, and that little was devoted to transforming it into something absolutely opposed to his whole spirit and method. In place of it they developed the Physiologus and the Bestiaries, in which scriptural statements, legends, and fanciful inventions were mingled with pious intent and with childlike simplicity.

In place of research came authority—the authority of the Scriptures as interpreted by the Physiologus and the Bestiaries—and these remained the principal source of thought on animated Nature for over a thousand years.

Occasionally, indeed, fear was shown among the rulers in the Church even of such poor prying into the creation as this, and in the fifth century a synod under Pope Gelasius administered a rebuke to the Physiologus; but the interest in Nature was too strong; the great work on Creation by St. Basil had drawn from the Physiologus precious illustrations of Holy Writ, and the strongest of the early popes, Gregory the Great, virtually sanctioned it.

Thus was developed a sacred science of creation and of the

divine purpose in Nature, which went on developing from the fourth century to the nineteenth—from St. Basil to St. Isidore of Seville, from Isidore to Vincent de Beauvais, and from Vincent to Archdeacon Paley and the Bridgewater Treatises.

Like all else in the middle ages this sacred science was developed purely by theological methods. Neglecting the wonders which the dissection of the commonest animals would have afforded them, these naturalists attempted to throw light into Nature by ingenious use of scriptural texts, by research among the lives of the saints, and by the plentiful application of metaphysics. Hence even such strong men as St. Isidore of Seville treasured up accounts of the unicorn and dragons mentioned in the Scriptures and of the phœnix and basilisk in profane writings. Hence such contributions to knowledge as that the basilisk kills serpents by his breath and men by his glance, that the lion when pursued effaces his tracks with the end of his tail, that the pelican nourishes her young with her own blood, that serpents lay aside their venom before drinking, that the salamander quenches fire, that the hyena can talk with shepherds, that certain birds are born of the fruit of a certain tree when it happens to fall into the water, with other masses of science equally valuable.

As to the method of bringing science to bear on Scripture, the Physiologus gives an example in illustrating the passage in the book of Job which speaks of the old lion perishing for lack of prey. Out of the attempt to explain an unusual Hebrew word in the text there came a curious development of error, until we find fully evolved an account of the ant-lion, which, it gives us to understand, was the lion mentioned by Job, and it says: "As to the ant-lion, his father hath the shape of a lion, his mother that of an ant; the father liveth upon flesh and the mother upon herbs; these bring forth the ant-lion, a compound of both and in part like to either; for his fore part is like that of a lion and his hind part like that of an ant. Being thus composed, he is neither able to eat flesh like his father nor herbs like his mother, and so he perisheth."

The same sort of science flourished in the Bestiaries, which were used everywhere and especially in the pulpits for the edification of the faithful. In all of these, as in that compiled early in the thirteenth century by an ecclesiastic, William of Normandy, we have this lesson, borrowed from the Physiologus: "The lioness giveth birth to cubs which remain three days without life. Then cometh the lion, breatheth upon them, and bringeth them to life. . . . Thus it is that Jesus Christ during three days was deprived of life, but God the Father raised him gloriously."

Pious use was constantly made of this science, especially by

monkish preachers. The phœnix rising from his ashes proves the doctrine of the resurrection; the structure and mischief of monkeys prove the existence of demons; the fact that certain monkeys have no tails proves that Satan has been shorn of his glory; the weasel, which "constantly changes its place, is a type of the man estranged from the word of God, who findeth no rest."

The moral treatises of the time often took the form of works on natural history, in order the more fully to exploit these religious teachings of Nature. Thus from the Dominican Thomas of Cantimpré, who called his book De Apibus (On Bees), we learn that "the wasps persecute the bees and make war on them out of natural hatred"; and these, he tells us, typify the demons who dwell in the air and with lightning and tempest assail and vex mankind—whereupon he fills a long chapter with anecdotes of such demonic warfare on mortals. In like manner his fellow-Dominican, the inquisitor Nider, in his book the Ant Hill, teaches us that the ants in Ethiopia, which are said to have horns and to grow so large as to look like dogs, are emblems of atrocious heretics, like Wyclif and the Hussites, who bark and bite against the truth; while the ants of India, which dig up gold out of the sand with their feet and hoard it, though they make no use of it, symbolize the fruitless toil with which the heretics dig out the gold of Holy Scripture and hoard it in their books to no purpose.

This pious spirit not only pervaded science, it bloomed out in art, and it meets us especially in the cathedrals. In the gargoyles overhanging the walls, in the grotesques clambering about the towers or perched upon pinnacles, in the dragons prowling under archways or lurking in bosses of foliage, in the apocalyptic beasts carved upon the stalls of the choir, stained into the windows, wrought into the tapestries, illuminated in the letters and borders of psalters and missals, these marvels of creation suggested everywhere morals from the Physiologus, the Bestiaries, and the Exempla.*

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* For the Physiologus, Bestiaries, etc., see Berger de Xivrey, Traditions Tératologiques; also Hippeau's edition of the Bestiary of Guillaume de Normandie, Caen, 1852, and such mediæval books of Exempla as the Lumen Naturæ; also Hoefer, Histoire de la Zoologie; also Rambaud, Histoire de la Civilisation Française, Paris, 1885, vol. i, pp. 368, 369; also Cardinal Pitra, preface to the Spicilegium Solismense, Paris, 1855, *passim*; also Carus, Geschichte der Zoologie; and for an admirable summary, the article Physiologus in the Encyc. Brit. In the illuminated manuscripts in the Library of Cornell University are some very striking examples of grotesques. For admirably illustrated articles on the Bestiaries, see Cahier and Martin, Mélanges d'Archéologie, Paris, 1851, 1852, and 1856, vol. ii of the first series, pp. 85–232, and second series, volume on Curiosités Mystérieuses, pp. 106–164; also J. R. Allen, Early Christian Symbolism in Great Britain and Ireland (London, 1887),

Here and there among men who were free from church control we have work of a better sort. In the twelfth and thirteenth centuries Abd Allatif made observations upon the natural history of Egypt which showed a truly scientific spirit, and the Emperor Frederick II attempted to promote a more fruitful study of Nature; but one of these men was abhorred as a Mussulman and the other as an infidel. Far more in accordance with the spirit of the time was the ecclesiastic Giraldus Cambrensis, whose book on the topography of Ireland bestows much attention upon the animals of the island, and rarely fails to make each contribute an appropriate moral. For example, he says that in Ireland "eagles live for so many ages that they seem to contend with eternity itself; so also, the saints, having put off the old man and put on the new, obtain the blessed fruit of everlasting life." Again, he tells us, "Eagles often fly so high that their wings are scorched by the sun; so those who in the Holy Scriptures strive to unravel the deep and hidden secrets of the heavenly mysteries, beyond what is allowed, fall below as if the wings of the presumptuous imaginations on which they are borne were scorched."

In one of the great men of the following century began to appear a slight gleam of healthful criticism: Albert the Great, in his work on the animals, dissents from the widespread belief that certain birds spring from trees and are nourished by the sap, and also from the theory that some are also generated in the sea from decaying wood.

But it required many generations for such skepticism to produce much effect, since we find among the illustrations in the edition of Mandeville published about the time of the Reformation not only careful accounts but a pictured representation of birds produced in the fruit of trees.*

This general employment of natural science for biblical illustration and the edification of the faithful went on after the Reformation. Luther frequently made this use of it, and his example controlled his followers. In 1612 Wolfgang Franz, Professor of Theology at Luther's university, gave to the world his sacred history of animals, which went through many editions. It contained a very ingenious classification, describing "natural drag-

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lecture vi; for an exhaustive discussion of the subject, see, Das Thierbuch des wormannischen Dichters Guillaume le Clerc, herausgegeben von Reinisch, Leipsic, 1890; and, for an Italian example, Goldstaub und Wendriner, Ein Tosco-Venezianischer Bestiarius, Halle, 1892, where is given, on pp. 369–371, a very pious but very comical tradition regarding the beaver, hardly more than mentionable to ears polite.

* For Giraldus Cambrensis, see the edition in the Bohn Library, London, 1863, p. 30; for Abd Allatif and Frederick II, see Hoefer, as above; for Albertus Magnus, see the De Animalibus, lib. xxiii; for the illustrations in Mandeville, see the Strasburg edition, 1484.

ons," which have three rows of teeth to each jaw, and he piously adds, "the principal dragon is the Devil."

Near the end of the same century, Father Kircher, the great Jesuit professor at Rome, holds back the skeptical current, insists upon the orthodox view, and represents among the animals entering the ark sirens and griffins.

Yet even among theologians we note here and there a skeptical spirit in natural science. Early in the same seventeenth century Eugène Roger published his Travels in Palestine. As regards the utterances of Scripture he was soundly orthodox; he prefaces his work with a map showing, among other important points referred to in biblical history, the place where Samson slew a thousand Philistines with the jawbone of an ass, the cavern which Adam and Eve inhabited after their expulsion from paradise, the spot where Balaam's ass spoke, the place where Jacob wrestled with the angel, the steep place down which the swine possessed of devils plunged into the sea, the position of the salt statue which was once Lot's wife, the place at sea where Jonah was swallowed by the whale, and "the exact spot where St. Peter caught one hundred and fifty-three fishes."

As to natural history, he sees, describes, and discusses with great theological acuteness the basilisk. He tells us that the animal is about a foot and a half long, is shaped like a crocodile, and kills people with a single glance. The one which he saw was dead, fortunately for him, since in the time of Pope Leo IV—as he tells us—one appeared in Rome and killed many people by merely looking at them; but the Pope destroyed it with his prayers and the sign of the cross. He informs us that Providence has wisely and mercifully protected man by requiring the monster to cry aloud two or three times whenever it leaves its den, and that the divine wisdom in creation is also shown by the fact that the monster is obliged to look its victim in the eye and at a certain fixed distance before its glance can penetrate the victim's brain and so pass to his heart. He also gives a reason for supposing that the same divine mercy has provided that the crowing of a cock will kill the basilisk.

Yet even in this good and credulous missionary we see the influence of Bacon and the dawn of experimental science; for, having been told many stories regarding the salamanders, he secured one, placed it alive upon the burning coals, and reports to us that the legends concerning its power to live in the fire are untrue. He also tried experiments with the chameleon, and found that the stories told of it were to be received with much allowance: while, then, he locks up his judgment whenever he discusses the letter of Scripture, he uses his mind in other things much after the modern method.

In the second half of the same century Hottinger, in his Theological Examination of the History of Creation, breaks from the belief in the phœnix; but his skepticism is carefully kept within the limits imposed by Scripture. He avows his doubts, first, "because God created the animals in couples, while the phœnix is represented as a single, unmated creature"; secondly, "because Noah, when he entered the ark, brought the animals in by sevens, while there were never so many individuals of the phœnix species"; thirdly, because "no man is known who dares assert that he has ever seen this bird"; fourthly, because "those who assert there is a phœnix differ among themselves."

In view of these attacks on the salamander and the phœnix, we are not surprised to find before the end of the century an attack on the basilisk; the eminent Prof. Kirchmaier, at the University of Wittemberg, treats both phœnix and basilisk alike as old wives' fables. As to the phœnix, he denies its existence, not only because Noah took no such bird into the ark, but also because "birds come from eggs, not from ashes." But the unicorn he can not resign, nor will he even concede that the unicorn is a rhinoceros; he appeals to Job and to Marco Polo to prove that this animal, as usually conceived, really exists, and says, "Who would not fear to deny the existence of the unicorn, since Holy Scripture names him with distinct praises?" As to the other great animals mentioned in Scripture, he is so rationalistic as to admit that behemoth was an elephant and leviathan a whale.

But these germs of a fruitful skepticism grew, and we soon find Dannhauer going a step further and declaring his disbelief even in the unicorn, insisting that it was a rhinoceros, only that and nothing more. Still, the main current continued strongly theological. In 1712 Samuel Bochart published his great work upon the animals of Holy Scripture. As showing its spirit we may take the titles of the chapters on the horse:

Chapter VI. Of the Hebrew name of the horse.

Chapter VII. Of the colors of the six horses in Zechariah.

Chapter VIII. Of the horses in Job.

Chapter IX. Of Solomon's horses and of the texts wherein the writers praise the excellence of horses.

Chapter X. Of the consecrated horses of the sun.

Among the other titles of chapters are such as: Of Balaam's Ass; Of the Thousand Philistines slain by Samson with the Jawbone of an Ass; Of the Golden Calves of Aaron and Jeroboam; Of the Bleating, Milk, Wool, External and Internal Parts of Sheep mentioned in Scripture; Of Notable Things told regarding Lions in Scripture; Of Noah's Dove and of the Dove which appeared at Christ's Baptism. Mixed up in the book with the principal mass

drawn from Scripture were many facts and reasonings taken from investigations by naturalists; but all were carefully permeated by the theological spirit.*

The inquiry into Nature having thus been pursued nearly two thousand years theologically, we find by the middle of the sixteenth century some promising beginnings of a different method —the method of inquiry into Nature scientifically—the method which seeks not plausibilities but facts. At that time Edward Wotton led the way in England and Conrad Gesner on the continent, by observations widely extended, carefully noted, and thoughtfully classified.

This better method of interrogating Nature soon led to the formation of societies for the same purpose. In 1560 was founded an Academy for the study of Nature at Naples, but theologians, becoming alarmed, suppressed it, and for nearly one hundred years there was no new combined effort of that sort until in 1645 began the meetings in London of what was afterward the Royal Society. Then came the Academy of Sciences in France, and the Academia del Cimento in Italy; others followed in all parts of the world, and a great new movement was begun.

Theologians soon saw a danger in this movement. In Italy, Prince Leopold dei Medici, a protector of the Florentine Academy, was bribed with a cardinal's hat to neglect it, and from the days of Urban VIII to Pius IX a similar spirit was there shown. In France there were frequent ecclesiastical interferences, of which Buffon's humiliation for stating a simple scientific truth was a noted example. In England Protestantism was at first hardly more favorable toward the Royal Society, and the great Dr. South denounced it in his sermons as irreligious.

Fortunately, one thing prevented an open breach between theology and science; while new investigators had mainly given up the mediæval method so dear to the Church, they had very generally retained the conception of direct creation and of design throughout creation—a design having as its main purpose the profit, enjoyment, instruction, and amusement of man.

On this the naturally opposing tendencies of theology and science were compromised. Science, while somewhat freed from its old limitations, became the handmaid of theology in illustrating the doctrine of creative design, and always with apparent

* For Franz and Kircher, see Perrier, La Philosophie Zoologique avant Darwin, Paris, 1884, p. 29; for Roger, see his La Terre Saincte, Paris, 1664, pp. 89–92, 139, 218, etc.; for Hottinger, see his Historiæ Creationis Examen theologico-philologicum, Heidelberg, 1659, lib. vi, Quæst. lxxxiii; for Kirchmaier, see his Disputationes Zoologicæ (published collectively after his death), Jena, 1736; for Dannhauer, see his Disputationes Theologicæ, Leipsic, 1707, p 14; for Bochart, see his Hierozoikon, sive De Animalibus Sacræ Scripturæ, Leyden, 1712.

deference to the Chaldean and other ancient myths and legends embodied in the Hebrew sacred books.

About the middle of the seventeenth century came a great conquest of the scientific over the theologic method. At that time Francesco Redi published the results of his inquiries into the doctrine of spontaneous generation. For over two hundred years the accepted doctrine had been that water, filth, and carrion had received power from the Creator to generate worms, insects, and a multitude of the smaller animals. This doctrine had been especially welcomed by St. Augustine and many of the fathers, since it relieved the Almighty of making, Adam of naming, and Noah of living in the ark with these innumerable despised species. But to this fallacy Redi put an end. By researches which could not be gainsaid, he showed that every one of these animals came from an egg; each, therefore, must be the lineal descendant of an animal created, named, and preserved from "the beginning."

Similar work went on in England, but with a more distinctly religious tendency. In the same seventeenth century a very famous and popular English book was that by the naturalist John Ray, a fellow of the Royal Society, who produced a number of works on plants, fishes, and birds; but the most widely read among all his books was entitled The Wisdom of God manifested in the Works of Creation. Between the years 1691 and 1827 it passed through nearly twenty editions.

Ray argues the goodness and wisdom of God from the adaptation of the animals not only to man's uses but to their own lives and surroundings.

In the first years of the eighteenth century Dr. Nehemiah Grew, of the Royal Society, published his Cosmologia Sacra to refute anti-scriptural opinions by producing evidences of creative design. Discoursing on "the ends of Providence," he says, "A crane, which is scurvy meat, lays but two eggs in the year, but a pheasant and partridge, both excellent meat, lay and hatch fifteen or twenty." He points to the fact that "those of value which lay few at a time sit the oftener, as the woodcock and the dove." He breaks decidedly from the doctrine that noxious things in Nature are caused by sin, and shows that they, too, are useful; that, "if nettles sting, it is to secure an excellent medicine for children and cattle"; that, "if the bramble hurts man, it makes all the better hedge"; and that, "if it chances to prick the owner, it tears the thief." "Weasels, kites, and other hurtful animals induce us to watchfulness; thistles and moles, to good husbandry; lice oblige us to cleanliness in our bodies, spiders in our houses, and the moth in our clothes." This very optimistic view, triumphing over the theological theory of noxious animals and plants as effects of sin, which prevailed with so much force from St. Augustine to

Wesley, was developed into nobler form during the century by various thinkers, and especially by Archdeacon Paley, whose Natural Theology exercised a powerful influence down to recent times. The same tendency appeared in other countries. Various philosophers did indeed show weak points in the argument, and Goethe made sport of it in a noted verse, praising the forethought of the Creator in foreordaining the cork tree to furnish stoppers for wine-bottles.

Shortly before the middle of the nineteenth century the main movement culminated in the Bridgewater Treatises. Pursuant to the will of the eighth Earl of Bridgewater, the President of the Royal Society selected eight persons, each to receive a thousand pounds sterling for writing and publishing a treatise on the "power, wisdom, and goodness of God, as manifested in the creation." Of these, the leading essays in regard to animated Nature were those of Thomas Chalmers, on The Adaptation of External Nature to the Moral and Intellectual Condition of Man; of Sir Charles Bell, on The Hand, as evincing Design; of Roget, Animal and Vegetable Physiology with reference to Natural Theology; and of Kirby, on The Habits and Instincts of Animals with reference to Natural Theology.

Besides these there were treatises by Whewell, Buckland, Kidd, and Prout. The work was nobly done. It was a marked advance on all that had appeared before in matter, method, and spirit. Looking back upon it now we can see that it was provisional, but that it was none the less fruitful in truth. Here we may well remember Darwin's remark on the stimulating effect of mistaken theories, as compared with the sterilizing effect of mistaken observations: mistaken observations lead men astray, mistaken theories suggest true theories.

An effort made in so noble a spirit certainly does not deserve the ridicule that, in our own day, has sometimes been lavished upon it. Curiously, indeed, one of the most contemptuous of these criticisms has been recently made by one of the most strenuous defenders of orthodoxy. No less eminent a standard-bearer of the faith than the Rev. Prof. Zoeckler says of this great movement to demonstrate creative purpose and design, and of the men who took part in it, "The earth appeared in their representation of it like a great clothing shop and soup kitchen, and God as a glorified rationalistic professor." Such a statement as this is far from just to the conceptions of such men as Butler, Paley, and Chalmers, no matter how fully the thinking world has now outlived them.*

* For Ray, see the work cited, London, 1827, p. 153. For Grew, see Cosmologia Sacra, or a Discourse on the Universe, as it is the Creature and Kingdom of God; chiefly written

But, noble as the work of these men was, the foundation of fact on which they reared it became evidently more and more insecure.

As far back as the seventeenth century far-sighted theologians had begun to discern difficulties more serious than any that had before confronted them. More and more it was seen that the number of different species was far greater than the world had hitherto imagined. Greater and greater had become the old difficulty in conceiving that, of these innumerable species, each had been specially created by the Almighty hand, that each had been brought before Adam by the Almighty to be named, and that each, in couples or in sevens, had been gathered by Noah into the ark. But the difficulties thus suggested were as nothing compared to those raised by the *distribution* of animals.

Even in the first days of the Church this had aroused serious thought, and above all in the great mind of St. Augustine. In his City of God he had stated the difficulty as follows: "But there is a question about all these kinds of beasts, which are neither tamed by man, nor spring from the earth like frogs, such as wolves and others of that sort, . . . as to how they could find their way to the islands after that flood which destroyed every living thing not preserved in the ark. . . . Some, indeed, might be thought to reach islands by swimming, in case these were very near; but some islands are so remote from continental lands that it does not seem possible that any creature could reach them by swimming. It is not an incredible thing, either, that some animals may have been captured by men and taken with them to those lands which they intended to inhabit, in order that they might have the pleasure of hunting, and it can not be denied that the transfer may have been accomplished through the agency of angels, commanded or allowed to perform this labor by God."

But this question had now assumed a magnitude of which St. Augustine never dreamed. Most powerful of all agencies to increase this difficulty were the voyages of Columbus, Vasco da Gama, Magellan, Amerigo Vespucci, and other great navigators of the period of discovery. Still more serious became the difficulty as the continent islands of the southern seas were explored. Every navigator brought home tidings of new species of animals and of races of men living in parts of the world where

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to demonstrate the Truth and Excellency of the Bible, by Dr. Nehemiah Grew, Fellow of the College of Physicians and of the Royal Society, London, 1701. For Paley and the Bridgewater Treatises, see the usual editions; also Lange, History of Rationalism. Goethe's couplet ran as follows:

"Welche Verehrung verdient der Weltenerschöpfer, der Gnädig,
Als er den Korkbaum erschuf, gleich auch die Stopfel erfand."

For the quotation from Zoeckler, see his work already cited, vol. ii, pp. 74, 440.

the theologians, relying on the explicit statement of St. Paul that the gospel had gone into all lands, had for ages declared there could be none; until finally it overtaxed even the theological imagination to conceive of angels, in obedience to the divine command, distributing over the earth the various animals, dropping the megatherium in South America, the archeopteryx in Europe, the ornithorhynchus in Australia, and the opossum in North America.

It was under the impression made by the beginnings of this new array of facts established by the earlier voyages of discovery that in 1667 Abraham Milius published at Geneva his book on The Origin of Animals and the Migrations of Peoples. An acute author says that this book shows, as no other does, the shock and strain to which the discovery of America subjected the received theological scheme of things. The book was issued with the full and special approbation of the Bishop of Salzburg, and it indicates the possibility that a solution of the whole trouble might be found in the text, "Let the earth bring forth the living creature after his kind." Milius goes on to show that the ancient philosophers agree with Moses, and that "the earth and the waters, and especially the heat of the sun and of the genial sky, together with that slimy and putrid quality which seems to be inherent in the soil, may furnish the origin for fishes, terrestrial animals, and birds." On the other hand, he is very severe against those who imagine that man can have had the same origin with animals. But the subject with which Milius especially grapples is the distribution of animals. He is greatly exercised by the many species found in America and in remote islands of the ocean—species entirely unknown in the other continents—and of course he is especially troubled by the fact that these species existing in those exceedingly remote parts of the earth do not exist in the neighborhood of Mount Ararat. He confesses that to explain the distribution of animals is the most difficult part of the problem. If it be urged that birds could reach America by flying and fishes by swimming, he asks, "What of the beasts which neither fly nor swim?" Yet even as to the birds he asks, "Is there not an infinite variety of winged creatures who fly so slowly and heavily, and have such a horror of the water, that they would not even dare trust themselves to fly over a wide river?" As to fishes, he says, "They are very averse to wandering from their native waters," and he shows that there are now reported many species of American and East Indian fishes entirely unknown on the other continents, whose presence, therefore, can not be explained by any theory of natural dispersion.

Of those who suggest that land animals may have been dispersed over the earth by the direct agency of man for his use or

pleasure he asks: "Who would like to get different sorts of lions, bears, tigers, and other ferocious and noxious creatures on board ship? who would trust himself with them? and who would wish to plant colonies of such creatures in new, desirable lands?"

His conclusion is that plants and animals take their origin in the lands wherein they are found—an opinion which he brings Moses to support with passages from the two narrations in Genesis which imply generative force in earth and water.

But in the eighteenth century matters had become even worse for the theological view. To meet the difficulty the eminent Benedictine, Dom Calmet, in his commentary expressed the belief that all the species of a genus had originally formed one species, and he dwelt on this view as one which enabled him to explain the possibility of gathering all animals into the ark. This idea, dangerous as it was to the fabric of orthodoxy and involving a profound separation from the general doctrine of the Church, seems to have been abroad among thinking men, for we find in the latter half of the same century even Linnæus incline to consider it. It was, indeed, time that some new theological theory be evolved; the great Linnæus himself, in spite of his famous declaration in favor of the fixity of species, had dealt a death blow to the old theory. In his Systema Naturæ, published in the middle of the eighteenth century, he had enumerated four thousand species of animals, and the difficulties involved in the naming of each of them by Adam and in bringing them together in the ark appeared to all thinking men more and more insurmountable.

What was more embarrassing, the number of distinct species went on increasing rapidly, indeed enormously, until—as an eminent zoölogical authority of our own time has declared, "For every one of the species enumerated by Linnæus, more than fifty kinds are known to the naturalist of to-day, and the number of species still unknown doubtless far exceeds the list of those recorded."

Already there were premonitions of the strain made upon Scripture by requiring a hundred and sixty distinct miraculous interventions of the Creator to produce the hundred and sixty species of land shells found in the little island of Madeira alone, and fourteen hundred distinct interventions to produce the actual number of distinct species of a single well-known shell.

Ever more and more difficult, too, became this question of the geographical distribution of animals. As new explorations were made in various parts of the world, this danger to the theological view went on increasing. The sloths in South America suggested painful questions: how could animals so sluggish have got away from the neighborhood of Mount Ararat so completely and have traveled so far?

The explorations in Australia and neighboring islands made matters still worse, for there was found in those regions a whole realm of animals differing widely from those of other parts of the earth.

The problem before the strict theologians became, for example, how to explain the fact that the kangaroo can have been in the ark and be now only found in Australia; his saltatory powers are indeed great, but how could he by any series of leaps have sprung across the intervening mountains, plains, and oceans to that remote continent; and, if the theory were adopted that at some period a causeway extended across the vast chasm separating Australia from the nearest mainland, why did not lions, tigers, camels, and camelopards force or find their way across it?

The theological theory, therefore, had by the end of the last century gone to pieces. The wiser theologians waited; the unwise indulged in exhortations to "root out the wicked heart of unbelief," in denunciation of "science falsely so called," and in frantic declarations that "the Bible is true"—by which they meant that the limited understanding of it which they had happened to inherit is true.

By the middle of the nineteenth century the whole theological theory of creation—though still preached everywhere as a matter of form—was clearly seen by all thinking men to be hopelessly lost; such strong men as Cardinal Wiseman in the Roman Church, Dean Buckland in the Anglican, and Hugh Miller in the Scottish Church, made heroic efforts to save something from it, but all to no purpose. That sturdy Teutonic and Anglo-Saxon honesty, which is the best legacy of the middle ages to Christendom, asserted itself in the old strongholds of theological thought—the universities. Neither the powerful logic of Bishop Butler nor the nimble reasoning of Archdeacon Paley availed. Just as the line of astronomical thinkers from Copernicus to Newton had destroyed the old astronomy, in which the earth was the center, and the Almighty sitting above the firmament the agent in moving the heavenly bodies about it with his own hands, so now a race of biological thinkers had destroyed the old idea of a Creator minutely contriving and fashioning all animals to suit the needs and purposes of man. They had developed a system of a very different sort, and of this we shall speak in the next chapter.*

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* For Abraham Milius, see his De Origine Animalium et Migratione Populorum, Geneva, 1667; also Kosmos, 1877, H. 1, S. 36; for Linnæus's declaration regarding species, see the Phil. Bot., 99, 157; for Calmet and Linnæus, see Zoeckler, vol. ii, p. 237. As to the enormously increasing numbers of species in zoölogy and botany, see President D. S. Jordan, Science Sketches, pp. 176, 177; also, for pithy statement, Laing's Problems of the Future, chap. vi.

TRUSTS THEIR OWN CORRECTIVE.

By GEORGE A. RICH.

THE test of a theory is to predict what will happen. When the cry was first raised a few years ago against the so-called trusts, and legislation of one kind and another was proposed, there were those who declared that if these combinations were left alone they would prove their own worst enemies. In other words, there were inherent weaknesses in the trust mode of doing business which, so far as the public was concerned, took all the teeth out of it. But the politicians and legislators brushed this contention aside as so much "rubbish" and "mere theory," and proceeded to attempt by statutory enactment what an early pope had tried by bull—that is, to stay the operation of a natural law. As to how well they succeeded, the failure of the Government to enforce the anti-trust law, and the rapid increase of these combinations in the face of popular opposition, constitute a sufficient answer. In the meantime the prediction, which they so curtly rejected, is receiving its verification in the developments now taking place among those great organizations of capital and industry.

The most effective of these corrective agencies are the unequal conditions brought about by the union of weak establishments with strong ones and the certainty of competition. The original object of the combination was to prevent disastrous competition. To be sure, the apparent success of some of the chief ones has dazzled the minds of business men and led to the formation of others for the sole purpose of realizing larger profits at the expense of the public. But an examination of the history of most of them will show that they grew out of bitter contests which threatened disaster and ruin to those engaged in the industry. This movement toward consolidation dates in this country from the close of the civil war. The return of capital to the normal channels of industry following that led to an overstimulation in many branches. Up to that time the productive capacity of the country had not been equal to its capacity of consumption. With manufacturers it had been a race for possession. But that point had been passed. Possible production was in excess of possible consumption, and it became with many a question of divide or fight. From the point of the manufacturers the preliminary combinations which followed were open to two serious objections: They could not be established by contract, because the common law treated such agreements as against public policy, while the statute law made it a misdemeanor to enter into them. Furthermore, where the law was evaded and such agreements

were entered into, they proved in nearly every case inoperative, from the fact that there was no power to enforce their conditions. The consolidation of competing interests or the principle of "division," therefore, seemed the only thing possible. This was notably the position of the Michigan salt manufacturers, whose association was the outgrowth of competition so fierce that many of them went to the wall. It is likewise true of the whisky trust. When the United States Government, near the beginning of the civil war, raised the internal revenue tax on whisky by successive stages from twenty cents to two dollars per gallon, with a considerable interval intervening between the several advances, an extraordinary stimulus was given to the manufacture. Distilleries without number sprang into existence. The result was that the output was far beyond the necessities of the market and it was a ruinous fight for life. In less degree this was the case with the cordage, cotton-oil, and bagging trusts.

Now, it is evident that combinations so formed stand in an anomalous position. Made up of both strong and weak establishments, the resulting corporation may be more powerful than some of its constituent members, but it is far from being equal to its prosperous ones. It is loaded down with old factories and antiquated machinery; it is capitalized at three or four times its actual value; and its managers are obliged, if they do what is expected of them, to support this rubbish and pay a profit besides. Were these combinations protected in the full control of their market, and were their products such that the public could not do without them or find a substitute for them, they might count on something like success. But capital is always on the outlook for prizes. It is always ready to make daring ventures in the hope of large returns. The fact that any one of these combinations can make eight or ten per cent on an inflated capital is clear evidence that the return for legitimate investment might be much greater. So the independent operator enters the field. The inevitable war of prices has been delayed a little, but the delay has permitted the growth of new and powerful organizations against the old concerns.

This point has been admirably illustrated in the experiences of the lead trust. It was not long ago that the annual meeting of the stockholders of that enterprise was held, and in the report of the president appeared this significant statement: "There has been, and always will be, competition in each class of goods manufactured by this company. It does not aim to obtain monopoly." The facts are, however, that at the beginning of 1892 the trust had control of all the lead-works in this country with the exception of two small establishments, one in Boston and one in Philadelphia; and even these were bound to it by ironclad

contracts. It was as full a control of an industry as could be had. Of course, large profits were possible; but capital was attracted to the field. As a result, new plants were started until there are at the present time works enough outside the trust to equal its output. But there is this striking difference between the trust and the independent manufacturers: the plants of the trust are capitalized for thirty million dollars; the independent plants, equal in capacity, represent an investment of only two million dollars.

The course of the linseed-oil trust has been analogous. In 1887, when the trust was started, it controlled between sixty and seventy per cent of the output of that product. As such it had the manipulation of the market and realized handsome profits, despite the fact that it had to face the independent crushers and was hampered by watered capital. But, to do it, it raised the price of linseed oil so high that the attention of others was drawn to the industry. The president of the trust in his report for 1891 said: "It is not considered by your board of directors advisable to publish a detailed statement of the affairs of the company, for the reason that we find by the experience of the past year that our statements find their way into the public press. If made in detail, information is given to our competitors, to the detriment of this company. There is no doubt whatever that the publicity given to our last annual statement caused the building of new works and consequent increase in competition." These independent crushers, strengthened by the newcomers and unhampered by weak plants, were able to wrest the market from the trust. Some months ago the trust sought a conference with its rivals and an effort was made to come to an understanding. That, however, has proved a failure, and competition ruled in the linseed-oil market.

Furthermore, it is impossible to get control of any article in general demand. Such an attempt may temporarily succeed, but there are powerful forces which will drag it down sooner or later. As an English writer says: "It is difficult to conceive of any body of capitalists being sufficiently powerful to monopolize an article in general demand and to use their monopoly for any length of time to the serious hurt of the public. Directly prices became prohibitive there would be a formidable movement in the opposite direction and the monopoly would break down."

The fate of the copper syndicate is a striking proof of this. This scheme consisted in nothing less than forestalling the market of the whole world in copper for the period of three years. This the managers attempted to accomplish, and did accomplish for a time, by buying the output of all the copper mines in the world for that period by agreeing to pay the mine owners thir-

teen cents per pound and one half of whatever the syndicate should be able to get above that. The immediate effect of this gigantic conspiracy was that the price of copper in the United States rose from thirteen to sixteen cents per pound. But the syndicate did not take the precaution to buy up all the old scrap copper in the world, nor all the metals that could be substituted in the arts for copper. Nor did it arrange with those who had been consuming copper that they should use it in the same quantities whatever the price. The result was that the syndicate collapsed, dragging down with it one of the great banking institutions of France, ruining an untold number of individuals, and driving to suicide the man who conceived the undertaking.

The same points of weakness are apparent in the other combinations now before the public. Despite the tremendous power of the sugar trust, it has never been able to control the market for any length of time, as an examination of the prices of sugar for the years of its existence will show. The independent refiners have forced it to reduce its quotations, and later buy their plants up at a high valuation if it wished to escape competition. No sooner has that been done, however, than new refineries have been started, as is the situation at the present time. Obviously there must be an end to this procedure, even for a corporation with such resources as the American Sugar Refining Company has. The same is true of the cordage trust. So strong an opponent of trusts as the New York Commercial Bulletin said of this at the time it was at the height of apparent prosperity: "The enormous profits which the trust is now making can not but lead to the establishment of additional independent plants. These will be in as strong a position for successful competition as has been found to be the case with the independent refiners of sugar. Under these circumstances the present enormous profits made by the cordage trust will not continue." The later fate of this same cordage company is a sad but striking commentary on the weaknesses to which such enterprises are open.

It is not contended that these corrective agencies will of themselves work the downfall of the trusts. That is an impossibility under the present industrial conditions. But they will fix a limit beyond which the trust can not go. Furthermore, they will hasten the overthrow of all those combinations which seek to carry along old and worthless plants and to follow discarded processes of manufacture and wasteful methods of business. The trust mode of doing business as a means of getting large capital and realizing the economies consequent on extensive production may be a success; but as a means of practicing extortion upon the public it is doomed to failure. Natural laws, after all, are stronger than the contrivances of man.

NEW LIGHTS ON THE PROBLEM OF FLYING.

By Prof. JOSEPH LE CONTE.

SOME of the readers of The Popular Science Monthly may remember that in November, 1888, I published an article in which I tried to show the physical impossibility of a true flying machine—i. e., one which could both lift and propel itself without the help of a balloon. The article was widely commented upon, the only objection urged being the threadbare one that more wonderful things than this have come to pass and will come to pass again. Since that time, however, a very elaborate series of experiments by Prof. Langley has thrown so much and so new light on the whole problem of flying, that I am forced to reconsider and modify somewhat the conclusions then reached. Having been asked to contribute a paper on the subject of flying to the World's Congress of Aëronautics, I, a few months ago, reviewed the whole subject in the light of these new experiments. The pressure of other duties at that time prevented me from putting my thoughts in final form, and I laid aside my notes. But I feel that I owe it to myself, as well as to The Popular Science Monthly, that I should again express my views under the changed conditions. This article, therefore, may be regarded as substantially what I would have given at the World's Congress if I had had time then to prepare it.

But this time I find it necessary to take up the subject from a more general point of view than before. My theme now is the problem of flying, both natural and artificial. I begin, therefore, with some discussion of the flight of birds.

The bird's wing has two distinct functions, viz., that of a propeller and that of an aëroplane. Both of these functions are performed by the wing in ordinary flight, but in different relative proportions according to the size of the bird and the extent of its wings. In insects and in small birds the wings act almost wholly as propellers. In large birds with great expanse of wings, except in rising, they act mainly as an aëroplane. This difference between small and large birds is fully recognized in my previous paper, but I did not then appreciate its supreme importance. Now it is on the properties of an aëroplane that the new light has been mainly shed, and it is therefore of its function in flight that I shall have most to say. First, however, a very few words on the bird's wing as a propeller.

The structure of a bird's wing is a marvel of exquisite contrivance—a wonderful combination of lightness, elasticity, and strength. The hollow quill, the tapering shaft, the vane composed of barbs clinging together by elastic hooks, making thus an

impermeable yet flexible plane—all this has been often insisted on by writers on design in Nature. But there are two points not so often noticed which especially concern us here.

1. Of the two vanes of each feather, the hinder one is much the broader. This, together with the manner of overlap, causes

FIG. 1.—LONGITUDINAL SECTION OF THE WING PLANE AND CROSS-SECTION OF THREE FEATHERS. *a*, shaft; *v*, *v'*, vane.

the feathers to rotate and close up into an impervious plane in the downstroke, and to open and allow the air to pass freely through in the upstroke, as shown in the figure (Fig. 1). This structure and arrangement produce the greatest possible effectiveness of the downstroke and the least possible loss in recovery for another stroke.

2. The plane of the wing is supported not along the middle, but along the extreme anterior border, as shown in Fig. 2, which

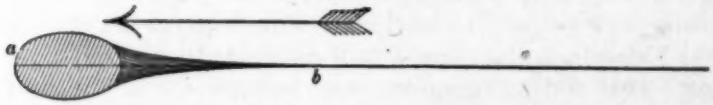

FIG. 2.—DIAGRAMMATIC CROSS-SECTION OF BIRD'S WING. *a*, wing bones; *b*, plane.

is a diagrammatic cross-section of the wing. The effect of the down stroke is to tip up the wing behind, as shown in Fig. 3. The whole force of the stroke, *a b*, is resolved into two components—one, *a c*, sustaining, and the other, *b c*, propelling onward. In easy flight, therefore, only downward flapping is necessary, al-

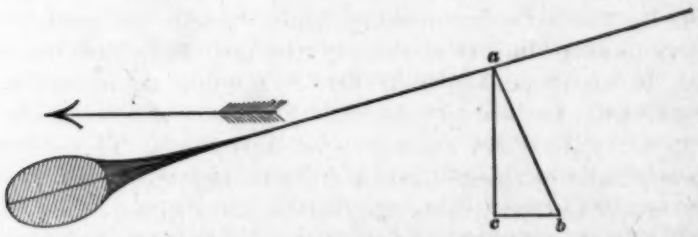

FIG. 3.—DIAGRAMMATIC CROSS-SECTION OF BIRD'S WING DURING DOWNSTROKE. *a*, *b*, whole force; *a*, *c*, part sustaining; *b*, *c*, part propelling.

though in rapid flight doubtless the stroke is also a little backward.

The same admirable adaptation is carried out in every part of the bird. The whole bird is an exquisitely constructed flying machine. The smallness of the head, the feet, and the viscera,

the lightness and the strength of the bones, all show that everything is subordinated to this one supreme function. In comparing a bird with an artificial flying machine it is necessary to bear this in mind.

But it is in the use of the wing as an aëroplane that the most wonderful feats of bird locomotion consist. If we are ever to achieve artificial flight it must be by the application of the principles underlying these. There are four of these feats of bird flight which require special notice as bearing on the subject of artificial flight. These are *hovering*, *poising*, *soaring*, and *sailing*.

HOVERING.—There is some confusion in the use of this term. It always refers to a maintenance of a body in one position in the air; but this may be done in two ways—either by vigorous flapping of the wings, or else, under certain conditions, with no motion of the wings at all. This latter, however, I shall call poising, and confine the term hovering to the former. In this sense hovering is seen in many insects and in the humming bird, and, among larger birds, in the sparrow hawk (*Falco sparverius*) and in the osprey (*Pandion haliætus*). In these it is seen that in hovering the body is inclined upward, and the stroke of the wing is decidedly forward as well as downward. The reason of this is, as already explained, that downward strokes give onward motion. But the main thing to be observed in large birds is the violent struggles necessary to maintain position compared with the ease of onward flight. This difference furnishes the key to the properties of an aëroplane, and was, I believe, first explained by Marey. In maintaining the body in the same position, as in hovering, the air gives way under each stroke of the wing, creating a downward current, thus greatly diminishing the effectiveness of the downstroke and increasing the loss in recovery or upstroke. In progressive flight, on the contrary, and more and more as the progress is more rapid, every phase of the downstroke is on new air. The wing strikes on three feet or six feet or ten feet or twenty feet of air, according to the velocity of progress, with every stroke. The air has not time to give way before the wing passes on to new, unmoved air. But if it is difficult to maintain one position, as in hovering, it is evidently still more difficult, on this principle, to raise the body directly upward. This explains the difficulty experienced by a large bird like the condor in rising, and yet the ease and grace of progressive flight when well up. We will see hereafter the great importance of this principle, as shown by the experiments of Langley.

POISING.—By this term I mean the maintenance of a fixed position with outstretched, motionless wings. During my boyhood I was fond of field sports of all kinds, and therefore a constant and accurate observer of the flight of birds; and yet, dur-

ing all that time, I never saw this feat. The reason was, that I lived in a perfectly flat country. I saw it for the first time when, at the age of fifteen, in going to college, I moved to a rolling country. It is best seen in a *bare* rolling country, like much of the western portion of the United States. The most perfect poising I have ever seen done was by the red-tailed hawk (*Buteo montanus*), on the bare, rolling lava plains of eastern Oregon. The conditions absolutely necessary are a rolling country and a steady breeze. The bird places himself above the brow of a hill with face to the wind. As long as the wind remains steady the bird retains his position, with outstretched wing, motionless.

The explanation is as follows: As already said, the bird places himself facing the wind just above the brow of a hill. The wind is deflected upward by the slope of the hill. The bird places his aëroplane (wings and tail) in a plane inclining slightly downward, but not so much inclined as the slope of the hill, so that the wind still strikes the under side of the aëroplane. In this position the force of gravity would carry him downward and forward, while the wind would carry him upward and backward. The bird skillfully adjusts the position of the aëroplane so that these two opposite forces shall exactly balance one another. As long as the wind remains steady his position is unchanged. If the wind changes in direction or in velocity, he wiggles himself a little, perhaps flaps once or twice, until he finds a new position of equilibrium, and again remains steady. This explanation is, I believe, complete.

SOARING.—It is well known that many large and long winged birds, such as vultures, hawks, pelicans, etc., will sweep about in wide circles with motionless, outstretched wings, not only maintaining their level, but rising in ascending spiral until they disappear from view. I have often watched their easy, graceful motion for hours, and am quite sure that it is accomplished without any expenditure of energy at all commensurate with the work of elevation. How is it done? There is no problem of bird-flight upon which so much has been written, and so little of any value. Let us see first what are the necessary conditions.

1. Every careful observer must have noted that the bird slopes downward along one half of the circle, so as to acquire high velocity, and then rises along the other half to a higher level than that from which he descended. How can he rise higher?

2. Every clear thinker must see that this feat is impossible, and every careful observer must have noted that it is never done —in still air. For if air is still, even if there were no friction and no tendency to fall toward the ground, the most that the velocity acquired by the down slope could do would be to carry the bird back to the same level again. Therefore, in still air the bird must

descend instead of ascend. A necessary condition, therefore, is wind; and, indeed, a soaring bird always drifts with the wind. The spiral is never upright, but always inclined to leeward. In soaring, the bird slopes downward with the wind, then turns and rises, facing the wind. How does wind help him?

3. The feat is physically impossible in an even current of air. It is strange that this is not seen at once; and yet excellent writers have become confused on this point. I confess that until recently I have been confused myself. It really follows as a necessary consequence of the last conditions—for an even current is still air to the bird immersed in it, precisely as the earth is practically still to us dwelling on it. If a cloud should intervene between the bird and the earth, it would be impossible for him to know whether he was in a current or not.

4. Therefore, in order to rise in a spiral without doing work by flapping, there must be differential currents, which the bird takes advantage of to do the work.

EXPLANATION.—Now, there are such differential air currents. Wind, like all other currents, increases in velocity from bottom upward. Experiments show that on a grass meadow the velocity eight feet above ground is double of that at one foot, and the velocity goes on increasing upward. A gentle breeze on the plain becomes a furious wind on the mountain-top. Like all other currents, too, there are differential currents side by side, the velocity along some stream lines being greater than along others. Also in air currents, especially, the velocity varies in time—i. e., the wind blows in puffs. These differential currents, both side by side and in altitude in time, would be evident at once if we could see the air. Now, the bird feels these invisible differential currents, and skillfully uses them to lift himself. In soaring, the bird slopes downward with the wind, acquiring thus great velocity, passes into a lower current of less velocity, then turns facing the wind, and shoots up a slope which carries him higher than the level of the start, then turns again in a current of still higher velocity, then descends again along a slope and repeats the same cycle.

To explain more definitely: Observe (1) that the lines of a bird are so fine that the front resistance is almost zero. There is practically only skin friction, which is also small. Observe (2) that with large aëroplane and rapid motion the fall by gravity is also very small. This is proved by experiments of Langley, to be described presently. Therefore, if the differential force of the air currents through which he circles is precisely equal to the skin friction plus the downward tendency, the bird will just rise to the level of the starting point; if greater, he will rise above that level. In order to rise, therefore, the differential force of the successive

currents must be greater than this small amount. As the bird is immersed in the current, and if he uses the whole available differential force in rising, none is left over for progress against the wind. He therefore drifts with the wind.

I have spoken thus far only of differential currents in altitude, for these can always be depended upon, but there may be also differential currents side by side. These might be utilized in the same way. The same may be said also of differential currents in time—i. e., successive puffs or gusts. The bird may take advantage of these. If so, he would slope down with the gust and come back and rise in the interval.

5. SAILING.—Many large birds fly with alternate intervals of flapping and sailing. But in such cases the bird always loses either velocity or height during the sail, which it recovers only by flapping. There is nothing remarkable in this. But some sea birds which live almost continuously on the wing and usually in a high wind, acquire an almost incredible expertness in the use of the wings as an aëroplane, and sometimes go for hours and over many miles of space without flapping once. The most wonderful bird in this regard is probably the albatross. On several voyages from Oregon to San Francisco I have watched these birds with their long, narrow wings rigidly extended, skimming the surface of the sea, then rising and wheeling and swooping, and again skimming, but without moving a feather for hours. I will briefly describe the phenomenon as I have seen it. The explanation will be brought out as I proceed.

I will suppose a wind aft, as was the case in most of my observations. The bird follows the boat, skimming the very surface of the sea perhaps for several hours; then, finding that he is losing ground, wheels about, facing the wind, shoots up to forty or fifty feet above the sea, then turns again with the wind, swoops down a steep incline, acquiring great speed both by the high velocity of the upper stratum and by the descent, then skims the surface again, and quickly overtakes the boat, to repeat the same evolution. With head wind these evolutions are more frequent. As before, he skims the surface behind the boat, but more quickly begins to lose ground; then rises and then wheels and swoops downward, leaving the boat; then, having acquired the necessary velocity, he again turns and skims the surface in air of small velocity, and in spite of head wind overtakes the boat, to repeat the same evolution. For hours these evolutions are repeated, the wings remaining motionless, with only varying position toward the wind.

Here, again, the bird takes advantage of the great difference of velocity between the lower and the upper strata of the air. Doubtless, also, with head wind, advantage is taken of eddies in the wake

of the boat. In all cases, if the wind slackens, the bird flaps now and then. If it stops, he flaps all the time. It can not be done in still air.

With the wind on the side the evolution must of course be different, but, as I have not watched this case, I will describe it as given by a writer in Nature (Nature, vol. xliii, p. 223, 1891).

Fig. 4 represents the stern of the boat and the circle of the bird's path. The arrows show the directions of the motion of the boat, of the wind, and of the bird. In the circle the strong line represents the higher portion of the circular sweeps and the light line the lower portion, almost in contact with the water's surface. It is seen, then, that the bird swoops down with the wind, skims the surface, and then rises against the wind. The sweep of the bird is here represented as a circle, because the boat is standing still; but really it is an advancing spiral, following the moving boat. The explanation here is exactly the same as in soaring, except that the differential force of the air currents is utilized in progress instead of in rising.

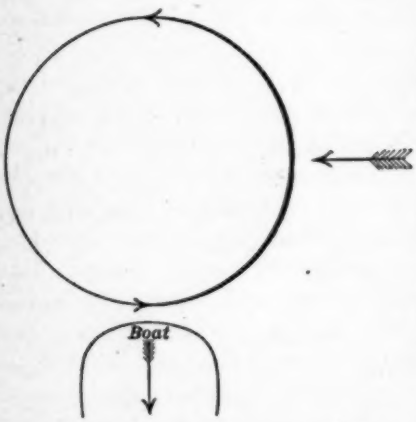

FIG. 4.—ARROWS SHOW DIRECTION OF WIND, OF THE BOAT, AND OF THE CIRCLING BIRD.

One more example: On the ferry boat going across the bay to San Francisco, with strong wind ahead and a little to the right (i. e., coming through the Golden Gate), I have several times seen a gull place himself behind on the left, just opposite the hind deck, and maintain his position with motionless wings for a half mile or more—I say motionless with confidence, because he was so near that I could see his eyes wink.

In this case I feel sure that the motion of the boat created an eddy in which the air was still or perhaps moving in contrary direction—i. e., with the boat, and perhaps also a little upward. If the air currents had been visible, I have no doubt the explanation would have been obvious. What I could not see, the bird felt and skillfully utilized.

Now, if birds, even the largest and heaviest of them, can thus play and gambol in the fiercest wind with the greatest ease and grace, and without serious expenditure of energy, but only by the skillful use of wings as an aëroplane, why can not we by artificial means—i. e., by a machine—do the same? The article before referred to was written to show why we can not.

The outline of the argument, the reader will remember, was as follows:

1. There is a limit to the size and weight of any locomotive machine, whether natural or artificial. This limit is the result of the law that while the strength of material and force of all kinds, whether by muscular contraction or by steam pressure, increase as the square of the diameter of muscle or of piston, the weight of the machine varies as the cube of the diameter of all parts. Thus with increasing size, weight must quickly overtake and pass beyond strength. This limit varies with the kind of machine. The limit of an efficient walking machine was probably reached in the largest land animals of previous geological times. For a rolling machine like a locomotive engine or a bicycle, where the weight is supported on wheels, or in a swimming machine where the weight is supported by water, and where, therefore, in both cases the whole energy is expended in progression, the limit is much higher; and, therefore, a locomotive engine and a whale may be heavier than any walking animal.

2. The limit of weight of a flying machine is very much lower than that of either a swimming, rolling, or a walking machine. The limit of an efficient, manageable flying machine is in fact reached in the largest birds, such as in the condor among long-winged and the bustard among short-winged birds, and to our surprise we find it only about fifty pounds. The condor can barely lift himself from the ground, although when well up he sails with ease and grace. There are, indeed, still larger birds, like the ostrich, but they can not fly. True, their wings are rudimentary, but they have become so only because these birds have passed beyond the flying limit.

3. Now, a bird is admirably constructed for economy of force. Not only is everything sacrificed to the one supreme object of flying, but the animal machine, using fats and starch for fuel and getting energy through the mechanism of nerve and muscle, is admittedly more economical and efficient—i. e., will develop more force and do more work for the same weight of fuel and machine—than any artificial machine yet devised. It seems hopeless to surpass it. Therefore, the weight of a machine that will be able to lift itself in the air can not exceed fifty or a hundred pounds.

4. But it is idle to talk of a flying machine with fuel and engineer and freight being less than many times this limit. Therefore, a flying machine which is anything more than a toy is impossible.

Such is a bare outline of the argument which seemed then—and to a large extent seems now—irrefutable. But Langley's recent experiments certainly put the question in a new and somewhat more hopeful light; and renewed reflection on the whole

subject, in the light of these experiments, has led me to some important modifications of my previous views. What, then, if any, are the fallacies in the above argument? *

1. We have spoken of two functions in the wing, viz., as propeller and aëroplane. These two are of necessity united in the bird. The bird's wing was not made at once—a special organ for a special purpose—but by modification of limbs. But there was only one pair of limbs to spare for the purpose of flying, and therefore one organ, the wing, was used for both functions. Now, there is probably a disadvantage in this; for short wings with great rapidity and sweep of the stroke are probably the best propellers, while long wings are undoubtedly the best aëroplanes. Thus in long-winged birds, like the condor, the ability to rise quickly and fly rapidly is sacrificed to easy, graceful, long-continued circling and sailing; while short-winged birds, like the turkey and bustard, rise more easily and fly more rapidly, but never remain long on the wing. There seems little doubt that the limit of weight in rising is higher in short-winged birds; and the great flightless birds were of this kind before they passed beyond the limit of flight and their wings became rudimentary. Now, it is needless to say that in artificial flying these two functions may and will be separated. The propeller will be used wholly for lifting and onward progress. I suppose, therefore, that the limit of weight may be raised higher than I have placed it. But if this were all, I can not think that it could be pushed much, if at all, beyond one hundred pounds. But this is not all.

2. We have said that the animal body using fats and starch as fuel, and getting force through the mechanism of nerve and muscle, is more economical—i. e., will generate more force and do more work with the same weight of fuel and machine—than any artificial contrivance yet devised or likely to be devised. This is certainly true; but there is another important element here concerned, viz., the *intensity* of the force—i. e., the amount of force developed and *work done in a given time.* This depends on the *rate* of combustion of the fuel. Now, there is a strict limit to the rate of combustion of fuel, and therefore of development of force, in the animal body. This limit may doubtless be greatly overpassed in an artificial machine. But be it remembered that this entails greater weight of fuel and of all parts of the machine en-

* Among these possible fallacies or oversight of my previous article I have not thought it worth while to mention the difference between the reciprocating motion of a wing and the steady pressure of a screw propeller such as would probably be used in any artificial machine; because I believe that, in the comparison, what is lost in the bird's wing in recovery for another stroke, is gained in the application of the force in the direction of greates efficiency.

gaged in the generation and transmission of force. What we want more specially is (1) a material stronger in proportion to weight than bone. This, no doubt, we have in steel tubes.* Here, then, is a positive gain. But (2) we also want a force more intense than muscular contraction, which is, I believe, about a hundred to a hundred and twenty pounds per square inch of cross-section. This can doubtless be surpassed, but not without increased weight of containing and transmitting parts. If anything can be gained in this direction (which is doubtful), against it must be set over the greater economy of the natural machine. The problem is an exceedingly complex one, and can be solved only by careful experiments. But let us admit that, by greater strength of material and greater intensity of force, the limit of weight of machine and fuel which can be lifted in the air may be pushed to several hundred pounds. This, I am sure, is as far as we can go on this score.

3. But the most important new light is found in the effect of motion on the sustaining power of an aëroplane, and the greatest flaw in my previous reasoning is the imperfect recognition of this principle.

As already stated, this principle was first brought out by Marey, and was alluded to in my previous paper, but its supreme importance was not fully appreciated until the experiments of Langley. In his hands it becomes almost a new principle, and one which must modify not only our theory of flying, but even our theory of projectiles. Langley's experiments bring out the unexpected result that in air a body does not fall the same distance in a given time whether it falls straight downward from rest or is affected with horizontal motion—that its motion in the latter case is not a resultant of distance of downward fall from rest and horizontal motion. The same is true of all bodies, but the difference is greatly exaggerated in the case of aëroplanes. According to his experiments, a thin aëroplane of material two thousand times the specific gravity of air, say aluminum, in perfectly horizontal position and free to fall, would take four times as much time to fall a certain distance if moving horizontally twenty feet per second as it would if falling directly downward from rest. With still greater velocities the time of falling a given distance is greater and greater, until it may become almost inappreciable. The reason is plain. The aëroplane falling straight downward must press the air out of its way. It takes time to do this. Now, if it is moving horizontally edge on, before the air can move appreciably, the plane is already on to new still air. Or, to put it more definitely, supposing the aëroplane to be one foot square,

* It is probably a mistake to suppose that aluminium or any alloy of that metal is stronger, weight for weight, than steel.

then, if falling straight downward, one square foot section of air must be moved in a given time; but if moving onward twenty feet per second, then twenty square feet must be started in motion in the given time. Thus with increasing velocity the air becomes more and more rigid because more and more must be started in motion in given time, until, if velocity is infinite, the air becomes immovably rigid.*

We have spoken thus far of a perfectly horizontal plane moving edge on, and therefore with no front resistance. But if the plane be slightly inclined upward in the direction of motion, then the onward motion would tend to sustain the plane. The whole air pressure may be resolved into two parts, one resisting onward progress and one sustaining the plane; and when this latter is equal to the weight the plane will not fall at all. Now, as velocity increases, less and less inclination is necessary to get the requisite sustaining force. But with less inclination comes also less front resistance. Thus at very high velocity the aëroplane may be placed nearly horizontal with proportionally small front resistance and yet sufficient sustaining power. Thus it follows from this important principle that instead of force increasing as the square of the velocity attained (or even higher rate), as in a steamboat, the increase of force with increasing velocity is unexpectedly moderate. This, of course, applies only to the aëroplane. Resistance to the attached machine follows the usual law. But this is small in comparison with the sustaining power of the æroplane. Therefore, once get a flying machine, even one of great weight, with its aëroplane well up in the air and moving onward, and there seems to be no physical impossibility of sustaining it indefinitely and giving it by means of suitable propellers a great velocity, say of forty to sixty miles per hour.

In the light of this new principle (for such it may be called) Langley and Maxim have constructed models of flying machines, and expect eventually to solve the problem of flying. A small model of a machine which he calls an aërodrone (air-runner) has been constructed by Langley, and was to have been exhibited at

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* A striking illustration of this principle is seen in the extreme rigidity of the jet issuing from the nozzle of a hydraulic pipe. The water is under a pressure of three hundred or four hundred feet head, and is projected with a velocity which would cut in two a man's body. If the jet is struck with a crowbar, the bar rebounds as it would from steel. In penetrating, say, half an inch, the bar encounters an immense quantity of water at once.

It is evident also that the same principle must apply to all bodies moving in the air, and therefore also to projectiles. There is, then, a kind of truth in the popular notion that velocity holds up or prevents the fall of a rifle ball—not, indeed, that the velocity itself holds up the ball, as popularly supposed (for it would not do so in a vacuum), but that the air is more effective in sustaining a moving body than one falling directly downward from rest.

Chicago at the World's Congress of Aëronautics. This model was fifteen feet long, with two transverse aëroplanes forty feet from tip to tip. Whether it was so exhibited or not I do not know. Maxim, it is said, is now constructing a flying machine on a large scale in London, but has not attempted yet to launch it. In both of these the aëroplane slightly inclined is the main reliance for sustaining when once in motion; so that the whole power of the engine and propellers is concentrated on rising and progress through the air.

Now, in the light of these experiments, what may we reasonably expect in the near future?

There are many difficulties in the way of success, which, of course, these men clearly see and will try to provide for. These are mainly three, viz.: (1) Difficulty of rising; (2) stability in progress; and (3) safety in alighting. We take these in succession.

1. RISING.—Every word I have said in my previous paper, only modified as to limit of weight, applies here still and without abatement. It seems to be impossible for any machine, natural or artificial, of greater weight than at most a few hundred pounds, to lift itself *straight up* in the air, or even to maintain itself in the same place like a hovering bird, by the force of propellers alone and without the aid of a balloon. Therefore, there must be some device other than, or in addition to, propellers to raise the machine in the act of starting. But observe, I said straight up. Many birds can not rise so. They must rise at very gentle incline. They must get onward motion before their wings can get full effect on the air. It is said that the mode of taking the condor is to build a pen, say, forty to fifty feet in diameter and six feet high, and put a carcass in the middle of it. The condor alights, but can not again rise at an angle which will take him over the fence. Many heavy-bodied, short-winged ducks rise from the water at so small an angle that they must use both feet and wings for thirty to forty feet in order to get onward motion enough to give effectiveness to their wings by coming in contact with larger masses of still air, as already explained. It follows, therefore, that the flying machine must have some station device to start it. It may be an elevator, but more probably it will be machine rollers on a railway. With aëroplane spread and slightly inclined and propellers directed a little backward, velocity might be got sufficient to sustain and finally with the help of the propellers to raise the machine. As far as I can learn, this is the plan of Maxim.

Viewed in the light of the new principle, there is certainly nothing impossible in this. But every machine is liable to accidents. It is absolutely necessary that we should be able to stop and go on again. Suppose in mid-flight anything should go

wrong and it is necessary to alight, how is the machine to rise again without the station device? A locomotive machine that can not stop anywhere and again resume its journey is an impracticable one. This, I think, will prove the greatest of all the difficulties.

2. STABILITY IN PROGRESS.—Once fairly up, as already seen, there is no reason why a moving aëroplane should not sustain a heavy flying machine indefinitely if nothing disturbs its equilibrium. Therefore, once up, we might hope for success in still air, or even possibly in a perfectly uniform current. But air currents are extremely variable in time (puffs and gusts) and in space—i. e., air streams of varying velocities and varying directions. When we see the frantic evolutions of a badly made kite, or of any kite if the steadying string breaks, we are warned of the danger of our aëroplane at high speed and with variable wind, unless skillfully managed, perhaps by means of several independent propellers and adjustable aëroplanes. In the bird we have the last perfection of skill acquired by constant practice and inherited through successive generations. Even if the science of aviation were perfect, the exquisite art necessary to manage such a machine seems almost hopelessly unattainable.

3. SAFETY IN ALIGHTING.—If the last—i. e., stability in progress—be attained, I suppose this also may be. In still air, by checking the velocity by the use of the propellers, the aëroplane would let down the machine with all the gentleness desirable. With head wind, also, there is no reason why alighting should not be successful. With the wind aft, it would be necessary to turn about and face the wind, as a bird does under similar circumstances. A parachute, with tubular opening atop, descends with perfect steadiness.*

4. To all these difficulties we must add the enormous hazard of a first attempt, the apparent impossibility of approaching success gradually, and thus practicing the difficult art of managing with safety.

CONCLUSION.—Under present lights, therefore, it is no longer justifiable to say, as I have previously done, that a flying machine is physically impossible. I therefore retract that expression. But the engineering difficulties are enormous and possibly insurmountable. At the present time the nearest approach to success in aërial locomotion is still to be found in the French dirigible balloon—i. e., a balloon propelled and steered by machinery—and for some time to come the best success may still be looked for in that direc-

* The Chinese have most ingeniously utilized this principle in the construction of little kites shaped like a bird, with wings and tail. These require no long, steadying tail, because the wings are made tubular at the tips, and the outrush of the air keeps the kite steady.

tion. In fact, the art of managing a true flying machine is so refined and the skill required so great, and in the absence of such skill the danger of a first attempt is so extreme, that probably the only way to achieve true flight would be by the use first of a dirigible balloon, and then gradually to decrease the sustaining gas and substitute the aëroplane and propeller.

In the distant future, and by means of such gradual approaches, the engineering difficulties in the way of a true flying machine may be finally overcome. If so, then we may look for the greatest success in the direction of the work of Langley and Maxim.

Addendum, January 23, 1894.

The above article was finished and sent to the publisher some time in October, 1893. In the January number of the American Journal of Science Prof. Langley published an account of another epoch-making series of experiments bearing on this subject. In his previous series he showed the enormous importance of onward movement in the sustaining power of an aëroplane. In this he shows the enormous variation of velocity in air currents from moment to moment. The whole air is in a violent turmoil from varying currents. In the above article I have shown that soaring and sailing are impossible without differential air currents; but the amount of difference of velocity of these currents shown by Prof. Langley was wholly unexpected. These experiments, therefore, show that the supply of force from this source available to the bird or to the flying machine is far greater than previously supposed. While they do not seriously vitiate any of my conclusions, they certainly place the subject of artificial flight in a still more hopeful light.

Mr. Bruce, of the Dundee antarctic whaling fleet, describes the whole of the district south of 60° south latitude as strewn with icebergs, which become very numerous south of 62°. On one day the author counted at one time from deck sixty-five of great size, besides many smaller ones. The highest berg seen from his vessel, the Balaena, was about two hundred and fifty feet high; but many were not more than seventy or eighty feet, the average possibly being about one hundred and fifty feet high. All these bergs are tabular, or weather-worn varieties of the tabular forms. They become pierced with caves, and these are sometimes connected with funnel holes, through which, as the swell beats up the caves, immense columns of spray are projected. They may be finely castellated, pillared, or arched. One was beautifully conical. The base of the bergs was colored pale brown by marine organisms, and other brown streaks were seen beyond the water-level. No luminous glow was observed. "Clothed in mist, they raise their mighty snow-clad shoulders to a stately height, or shine forth brilliantly in the sun. Although they are of the purest white, yet they glow with color. The crevices exhibit rich cobaltic blue, and everywhere are splashes of emerald green."

THE METHOD OF HOMING PIGEONS.

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WHEN Sir John Lubbock * rotated a paper disk upon which ants were moving in a given direction and the ants turned so as to maintain their course, it seemed as if they were endowed with some mysterious sense or power of direction, like that of a magnetic needle upon its pivot. When he substituted for the plain disk a circular hat-box, which, as he thought, must constitute for an ant the entire visible universe, and still the ants turned as the box was rotated, the fact seemed proved. Ants must have located within their bodies, and independent of ordinary sensory impressions from the external world, the power of going in any direction they wish. This conclusion is far reaching in its consequences. If ants possess such mysterious power, may it not exist in other, or all, animals? It must be of the nature of a special sense. Where, then, is the sense organ? How should ideas of animal sensation be modified by it?

Many writers would have ceased experimenting at this point, and gone off into chapters of ecstatic hypothesis about this fathomless mystery, this unmistakable "sense of direction" developed to such perfection in so humble a creature. Not so with Lubbock. When he covered the hat-box, then rotated it, the ants did not turn, but were turned with the box; or when he shifted the position of his candles to the opposite side, as he rotated the box, the ants did not turn. And so their action fell from the realm of exquisite mystery to take its place among such commonplaces as that of the sailor steering his course by the lighthouse or the stars, or that of a man guided home by the light of his own camp fire.

A considerable literature, *pro* and *con*, has gathered about the subject, in which we find frequent use of such expressions as "direction-sense," "*sens de la direction*," "sense of orientation," "*faculté d'orientation*," "instinct of location," "magnetic sense," "*Orientierungssinne*," "*Gefühl der Kardinalrichtungen*," and many more. By whatever terms designated, the idea is that animals possess some special sense, some occult faculty, by which, without reference to external objects, they are able to guide their movements aright. This power, it is commonly thought, is not possessed, or only in a rudimentary degree, by civilized man, is more highly developed in savages, and may be found in its perfection in certain migratory animals.

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* Sir John Lubbock. Ants, Bees, and Wasps. New York, 1882. See pp. 260 ff.

The literature* is open to the general criticism that the strange and exceptional is noted, while by far the more important, common, and usual occurrence rarely appears in print; and thus queer stories of dogs and cats, horses, mules, birds, insects, and even men,† who are able to point unerringly north, no matter how blindfolded or manipulated, come to predominate. Still, as the methods of animals have come to be studied with scientific

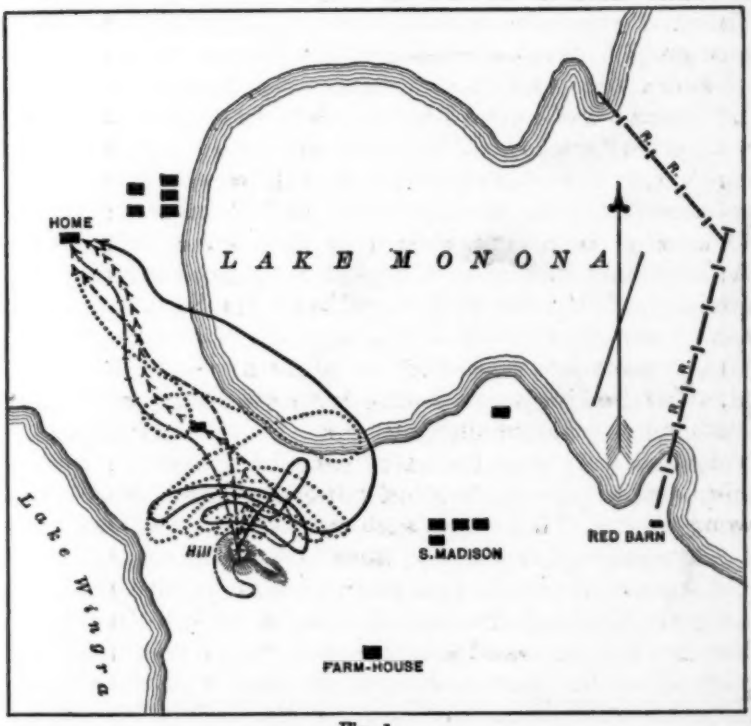

Fig. 1.

Flight of six pigeons, open cage.

accuracy, these notions have been compelled to flit from one form to another in most lively fashion.

Migratory birds, most careful study has proved, learn their route from "zone to zone," and follow it solely by means of vision. "This," Mr. Wallace says, "is now well ascertained." The work of Sir John Lubbock, of Forel, and the perfectly conclusive experiments of Mr. and Mrs. Peckham,‡ leave no resting place for

* For a running discussion of the subject, refer to Science, vol. xx, pp. 207, 248, 291, 318, 358.

† Rudski. Ueber ein angeborenes Gefühl der Kardinalrichtung des Horizonts. Biologisches Centralblatt, vol. xi, p. 63.

‡ Proceedings of the Natural History Society of Wisconsin, 1887, pp. 113 ff.

the idea among insects; and developments in anthropology teach that savages depend solely for directions upon a skillful use of the external signs of Nature.

All this may be true. It still remains an utter impossibility that a homing pigeon can return from a distance of over a thousand miles if unaided by some special "sense of direction." Such a view is rarely held by a practical pigeon fancier. He knows too well how many birds he loses, even with most careful short-distance training. He has observed that his birds, until they have learned the country, generally consume time enough to enable them to hunt over mile by mile a vast area, and that they can do nothing in a fog or snowstorm, or if blindfolded or hooded. Twenty years ago Leonard * wrote as follows: "Some writers, chiefly poets and romancers, would have us believe that the carrier pigeon finds his way home from remote places by a kind of instinct; but this is not the case. Its flight is guided by sight alone. When let loose from confinement, it rises to a great height in the air by a series of constantly enlarging circles until it catches sight of some *familiar landmark* by which to direct its course."

Had "poets and romancers" continued sole occupants of the field, the following notes would have served no other than the private purpose for which they were taken. † As it is, a number of attempts have recently been made by men of high scientific attainments to prove theories of "direction-sense" by feats of the homing pigeon. In general, such attempts are made in line with one or the other of two assumptions. According to the one, "direction-sense" is ascribed to some mysterious, direct, and immediate perception or sensation of location or direction in space. More often it is supposed to be a sort of "dead reckoning" which the organism has become able to keep—that is, the animal has come to have a feeling, definite or vague, as to how long, how fast, and which way it has traveled or has been carried. Two papers may be cited as giving possibly the best expositions of these two views. The one by Prof. Exner ‡ adduces evidence to prove the "dead-reckoning" theory; the other, by Prof. Caustier,* attempts to establish that of immediate perception. Both agree as to the organ—viz., the membranous labyrinth, especially the semicircular canals.

There is nothing impossible about Exner's explanation. All

* E. B. Leonard. Pigeon Voyagers. Harper's Monthly, vol. xlvi, p. 659, 1873.

† My own experiments related to a study of extreme fatigue of the nervous system, and for this purpose homing pigeons were furnished me by the generosity of Dr. S. Weir Mitchell. It thus became necessary, in order to credit accurately the amount of effort put forth in any given instance, to observe their habits and methods of flight.

‡ S. Exner. Das Räthsel der Brieftauben. Wien, 1892.

* E. Caustier. Les Pigeons Voyageurs. Revue de l'Hypnotisme, July, 1892, p. 10.

animals, by the processes going on in their bodies, must have some notion of time. This would give the "how long" element in the problem. The "how fast" might be given by such an in-

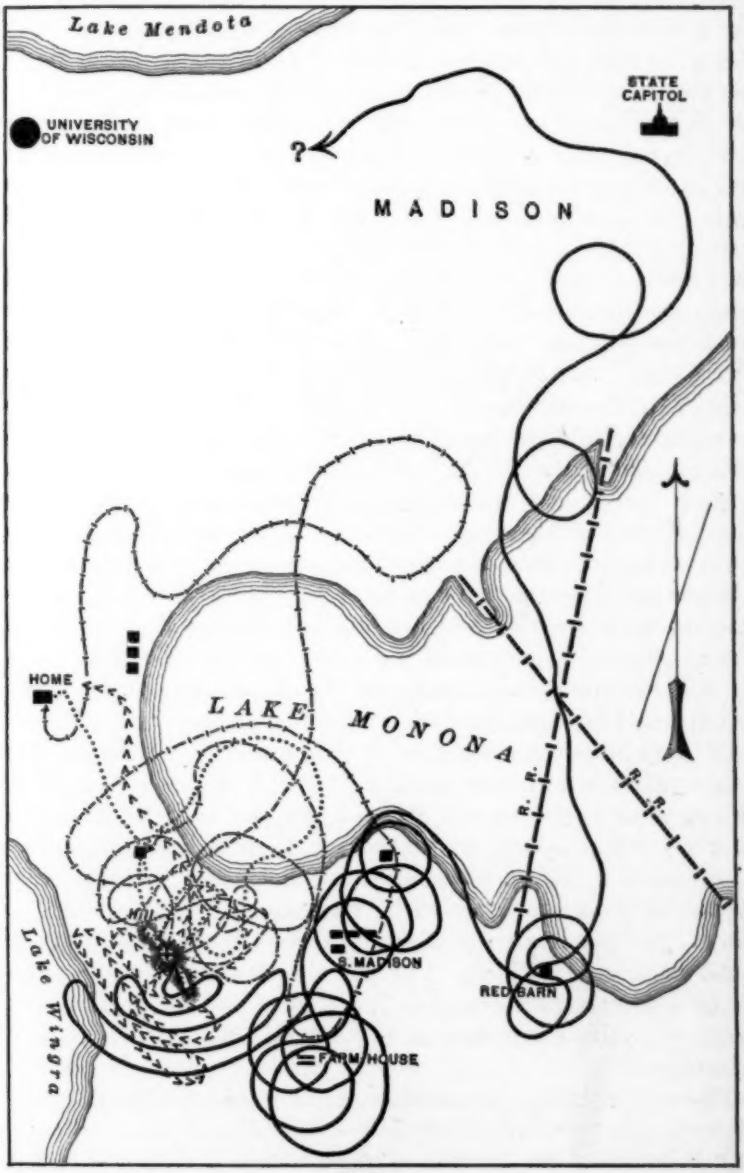

Fig. 2.

Flight of six pigeons, covered cage.

strument as we find in the otoliths resting on the sensory hairs of the *maculæ acousticæ*, these hairs bending under the weight more or less, according to rate of movement. The "which way" could

easily be indicated by a bending of the sensory hairs of the *cristæ acousticæ* as the liquid in the semicircular canals is thrown this way or that by angular deviation of line of motion. Experimental test of the theory is impossible, since, after injury of a single semicircular canal, the birds refuse to fly at all. It must rest, therefore, upon facts obtained from observation of habits and methods employed by homing pigeons. If it is true, there should appear some relation between the flight of a bird home and the course by which it has been carried to the place of liberation. It should either tend to retrace its course or to follow a straight line home. However, the writer has not been able to record a single fact which points in this direction.

Graver objections must be admitted to obtain against the theory of M. Caustier, tinted as it is by the "electro-magnetic" romancing of the French hypnotists. He tells us of the bird, endowed with "*une nature eminemment électrique*," of "*l'électricité de l'air*," of "*magnétisme terrestre*," of "*l'action physiologique du magnétisme*," and the like. This means that pigeons can sense currents of atmospheric electricity or terrestrial magnetism in such a manner as to be guided by them; and this can hardly stand even as passing theory, while it remains so thoroughly proved by the experiments of Hermann,* and these have been confirmed with powerful dynamos in at least two laboratories in this country, that the magnetic field has not the least physiological influence ("*nicht die geringste Wirkung*") upon the action of any tissue or sense organ or upon the animal as a whole.

But what say homing pigeons for themselves?

Of first importance to the study of a homing instinct is the method which an animal employs to mark or locate its home. On leaving a new camp for a day's hunt in the Bad Lands, a man naturally turns about and makes a mental note of prominent buttes in the vicinity. This butte with three pine trees on top is just to the left of the gulch where the tents are pitched. "I can tell it as far as I can see it," and he strikes out. Why may not other animals adopt a similar method? Concerning bees, Thompson has observed that, "if the position of a hive be changed, the bees for the first day take no distant flights till they have thoroughly scrutinized every object in its neighborhood." This would seem to indicate a rational method of procedure.

Upon their arrival in Madison, Wis., from Worcester, Mass., the pigeons were kept confined in a large loft which had but one window, and this happened to be upon the side next another barn close by, so that it afforded no view of the surrounding country.

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* Hermann. Hat das magnetische Feld direkte physiologische Wirkung? Pflüger's Archiv, vol. xliii, p. 217, 1888.

This arrangement was accidental at the time, but served very well a subsequent purpose. Five of the birds were "youngsters," and had never been liberated anywhere. On January 30 (1892), six months after their arrival, I let out these young birds one at a time, and with my wife to assist, and with spyglass, watch, and note-book at hand, we studied every act of each of the birds as long as we could keep them in sight. Since they all adopted precisely the same method of locating their loft, a description of one case will suffice.

A black Antwerp, let out at 4 P. M., flew to the ridge of a house eighty yards to the northwest, and sat for fifteen minutes, turning first this way, then that; looking eagerly the whole time; neck stretched out and head not still for a moment. This pigeon happened to alight on the north side of a chimney which came up through the ridge of the house. Its position was so close to the chimney that with stretching its neck as far as possible in both directions a considerable sector of the landscape must have been hidden from view. A few minutes after it alighted I recorded the remark, "If it is really in earnest about seeing everything in the neighborhood, it ought to go around to the other side of that chimney." Its first move, after fifteen minutes of looking, was a simple flit around the chimney. Here it stood for five minutes longer, looking attentively the whole time. It then flew a hundred yards south to the peak of a higher house, where six minutes more were given to observation from this new position. It next flew to a small, low house a hundred yards north. Here it remained scarcely a minute, whence it flew a hundred yards southeast to the peak of the highest house in the vicinity, where eight minutes more were devoted to observation. It now struck out to the southwest over a hill and grove and was lost to view until ten minutes past five, when it alighted on the loft. This flight may have been for the purpose of exploration and location, it probably was, in part at least; but leaving that out of the account, the bird spent thirty-five minutes doing nothing but look at its surroundings. The others consumed about the same time in the same way. In this we find the power to return laid in the painstaking visual localization of the home spot. One of the old birds, which escaped by accident, acted in a very different manner. After a few rapid circles, he flew straight for Madison and was not seen for three days; when, failing to find his old home in Worcester, he returned to the loft.

The next experiments were directed to determining the course taken by a pigeon in his return flight. The method employed is essentially the same as that used by Sir John Lubbock with the ants. The pigeons were taken to a convenient distance and liberated, and tracings of their flight were dotted off upon a chart of

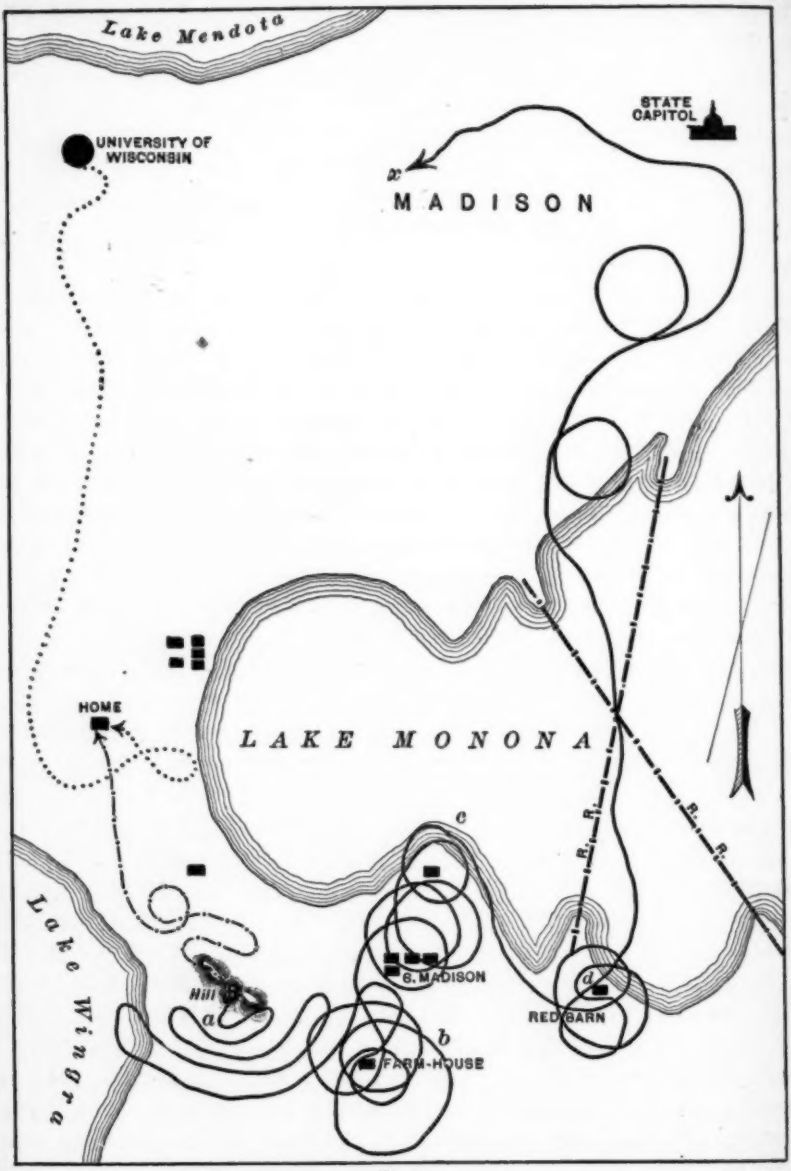

Fig. 3.

Three successive flights of pigeon No. 2.
——— *First flight, May 29.*
—·—·— *Second " June 5.*
····· *Third " June 21.*

the country. About fifty such tracings were taken, of which a few of the more instructive are reproduced below.

A few days of freedom were allowed, in order that the birds might more exactly locate their loft; then all were again confined

in preparation for the following experiments for nearly four months.

On May 29th six pigeons were caught at random and carried in a cage, the top and sides of which were made of open-mesh wire netting to allow free vision, to the top of a hill about half a mile southeast of "home." The birds were liberated singly, and the course flown by each in returning to loft may be seen by a glance at Fig. 1. At the same time, six other birds, also taken without selection, were carried to the same place in a basket closely wrapped in a heavy black shawl. Tracings of their homeward flights are reproduced in Fig. 2.

By comparing the two figures may be seen the influence of vision upon directness of return flight. In Fig. 1, five of the birds are seen to start toward home at once; one, a young bird out of the loft for the first time, flies in the wrong direction a short distance, turns sharply about, and alights upon the first house on the line toward home. Three pigeons fly home without preliminary circling. Fig. 2 shows not a single direct course. Two begin circling in the wrong direction. One of these persists in his false bent to the extent of searching over the whole city of Madison. In the case of Fig. 1, the birds, most of them, see home very soon and fly directly to it. Fig. 2 shows more of the method which a pigeon adopts in covering unknown territory.

By comparing successive tracings of the same bird, may be seen the effect of education—i. e., improvement in good birds, failure to improve in poor ones. The first is well shown in Fig. 3, the three different lines representing three successive flights of pigeon No. 2. As this is a typical case, let us follow its development a moment. No. 2 has been carried from the loft in a covered basket to the hill half a mile distant. Not having any idea as to which direction he has been taken, he naturally starts out the wrong way. His first thought, if I may so speak, is to look around for some familiar object. So at *a* he turns about and is occupied with looking over the landscape, while he describes a number of semicircles back and forth around the place of starting. He evidently sees nothing until his widening circles bring him over a group of buildings around a farmhouse at *b*. Among these is a red barn, and close to the loft is a red house. This looks quite like home, and he swoops down toward it. On closer examination, however, he fails to discover the familiar barn, the pigeonholes, and alighting board. After making four circles low down over and among these buildings, he rises high in the air again to take another look. All to the south and west are lake and marsh and woods, with but few farmhouses visible. Toward the north he sees a cluster of houses—South Madison. He looks them over in the same way. From *c* he catches sight of another

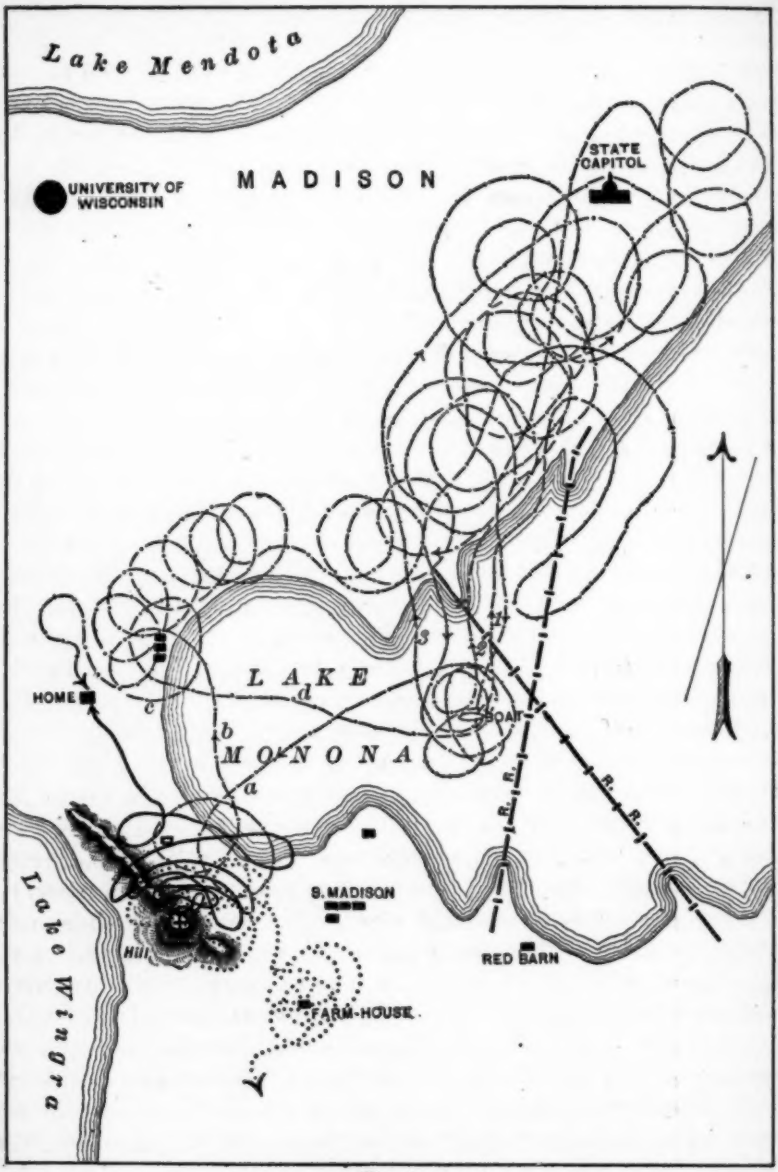

Fig. 4.

Three successive flights of pigeon No. 5.
——— *First flight, May 29.*
——— *Second " " 30.*
▸.....*Third " June 5.*

red barn at *d*, and goes to inspect it. Failing to find anything here, he must look farther. He has just come from the west. To the south and east are nothing but lake and woods again. To the north lies the densely settled portion of Madison. Possibly

he sees the red brick courthouse near the State Capitol. He flies thither, but on reaching the city nothing looks familiar, and he spends little time in circling over it. He is soon lost to view at *x*. His course thus far measures about ten miles; time, a trifle over eight minutes. He was liberated at four o'clock, and after being lost at *x* he was next seen as he swooped down from the west to settle upon the roof of the loft at 5.10. As it is almost certain that he flew continuously, this leaves sixty minutes unaccounted for, and at a moderate estimate fifty miles of search-line not drawn upon the chart. Were it possible to fill this in, how much "sense of direction" should we need to invoke to account for his finding home? He has flown certainly eleven miles, almost as surely sixty, to find a good-sized barn half a mile away.

The result of education is seen in his subsequent flights. A week later he flies home from the same hill in less than a minute. Two weeks later still he flies from the university almost as straight as though he did have a "sense of direction." Upon the question of education, however, we must compare Fig. 3 with similar tracings of another bird, No. 5, given in Fig. 4. In the first trial No. 5 (continuous line, Fig. 4) succeeds in reaching home from the open cage without much difficulty. Liberated from a boat on Lake Monona for a second trial, he flies wildly (the broken line seen in Fig. 4). This tracing gives an index to the harum-scarum character of the bird. Unlike No. 2, which looks over the likely places carefully and then moves on, No. 5 is careless, has no confidence in his ability, and consequently looks the same ground over and over again (see 1, 2, and 3, Fig. 4). At *a* he flies out to the familiar hill, and thence does strike out in the right direction (*b*, Fig. 4) and goes close to home (*c*), but stupidly fails to recognize it, and flies back to the boat again for a fresh start. No. 5 shows no improvement with education. When carried to the hill for a third trial (dotted line, Fig. 4), he circles for a moment, and then seeing the red barn by the farmhouse, he starts off the wrong way. This bird, with eleven others, is subsequently sent away six miles, and he alone of the twelve fails to return. No doubt there are stupid pigeons as well as stupid men.

Two points of some little interest from their bearing upon comparative psychology may be mentioned in this connection. The first is the definite reaction to color which the pigeons unquestionably gave. Until they had completed their education so far as to know the landscape pretty well, and had learned that there are many red houses and barns in the world, a red building was enough to determine their flight with almost mathematical precision. The second point is one which the Peckhams have noted

with reference to wasps*—viz., if wasps are taken away from their nests and liberated over water, they fly toward the nearest land, although their nest is in the opposite direction. In liberating the pigeons from the boat this reaction was tested a great many times and never failed.

The tracings speak too plainly for themselves to require further comment. If any are able to extract "direction-sense consolation" out of them, they are entirely welcome to it.

The criticism naturally arises at this point that the pigeons are not trying to find home at all. They may be flying for pleasure or exercise. Two things may be said in reply: First, theories of "direction-sense" have been based upon the air-line course which a pigeon has been supposed to take, "after getting his bearings," from place of liberation to loft. This, as we have seen, comes only after training. In the second place, after a little observation, it is easy to distinguish from the sportive cavortings for pleasure the eager darting flight of search.

If, however, they fail to give evidence of "direction-sense," may not such tracings show something of even greater importance? All animals, from amœba to man, spend a good share of their time searching for something or other. May there not be a fundamental logic of search as universal as the search itself? Naturally, if this is so, those animals whose life depends most closely upon finding the objects of their search would come to have the power and the logic of search most highly developed. We may then ask, What is the path or curve of logical search? It could hardly be a straight line, since the effort necessary to search must have a tendency to cause any animal to search over nearest ground first, inasmuch as turning or looking around is easier than moving the body ahead as far as the animal is able to see or feel ahead. We see this exemplified in the circling of hawks and the circling of dogs when starting out to cover a field. It could not be a circle, however, in case of an animal with memory to avoid covering the same ground twice.

To test the matter experimentally, a number of people kindly drew for the writer the path each would take to find an object, the proximity or direction of which is unknown. The object is supposed to lie upon a uniform field. Types of the curves handed in are given in Figs. 5 to 8. Undoubtedly the logical curve is the one submitted by Prof. Story (Fig. 5). It will be recognized to be a peculiar spiral, the involute of a circle, the characteristic of which is that the convolutions are always the same distance apart. This distance will be, of course, twice the distance at which the object is visible. The curve given by the majority is drawn in

* *Loc. cit.*, p. 17.

Fig. 6. This is a shade less ideal. The searcher, supposing him to be at the center, first looks around as far as he can see, then goes straight out twice the distance at which the object is visible, and begins following circles, each one being twice the visible distance from every other. A number of rectilinear figures were

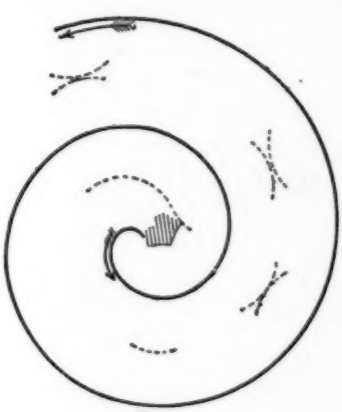

Fig. 5

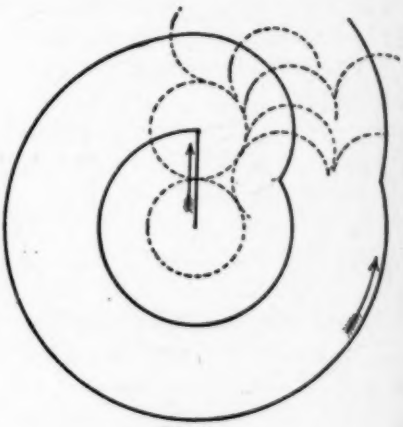

Fig. 6

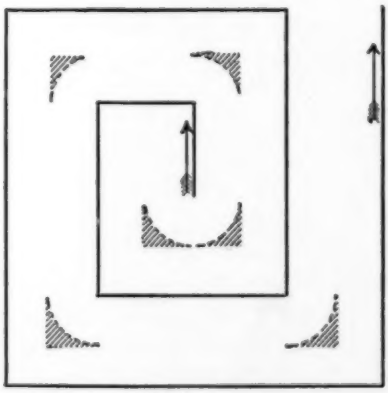

Fig. 7

Fig. 8

Fig. 5. Involute of a circle, the figure suggested by Professor Story as the ideal curve of search.

Fig. 6. Curve of search given by a number of persons.

Figs. 7 and 8. Rectilinear search lines.

The shaded portions in Figs. 5 to 8 represent parts of the field not visible without looking backward or deviating from the search curve.

Dotted arcs indicate limit of vision.

received, types of which are reproduced in Figs. 7 and 8. These are a stage above the fundamentally logical. They clearly belong to the realm of the practical. We might call them "Yankee" search curves. They are practical, of course, because it is easier to follow a straight line than a curve.

A simple experiment was next devised, in which a person

actually sets out to find a red tennis ball on a grassy lawn, his steps being plotted while he is making the search. The ball was placed in all cases so that it could be seen from a distance of ten steps and at a uniform distance forty steps from the center stake, in order that the tracings of different persons could be compared as to time and length of course traversed.

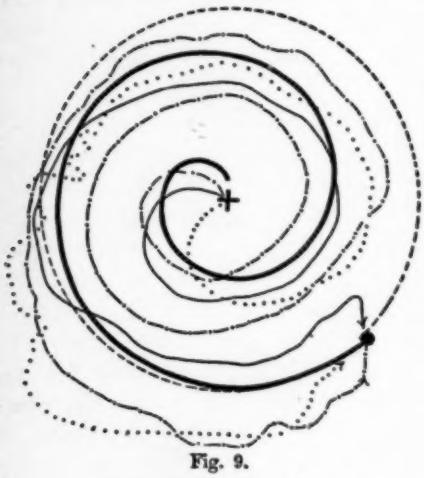

Fig. 9.

+ *Starting point.*
— — *40 step circle*
▬▬ *Ideal curve.*
——— *Path of T. P. H. 4 minutes.*
— — " " *T. L. B. 7* "
..... " " *L. W. 5* "

No attempt was made to do more than was necessary to obtain a suggestion which might serve to indicate the logic and method of the pigeons. In all only sixteen tracings were taken, and this number includes one experiment on a shepherd dog. Of the whole number, ten conform more or less closely to Prof. Story's curve. Three of the best of these are reproduced in Fig. 9. Two correspond evidently to the circular type (Fig. 6). These are given in Fig. 10, together with the only one which is in any degree rectangular, the "Yankee" type, and this was not made by a Yankee at all, but by an Irish boy twelve years of age. Three of the curves are hardly susceptible of logical classification.

A point of interest in this connection attaches to the dotted line in Fig. 9. This represents the path of L. W., the university carpenter, a man sixty-five years old, who had worked at his trade of straight lines and right angles for forty-five years. I had expected a typical rectangular curve. Instead he gave an ideal spiral. After finding the ball, however, he volunteered the following suggestive remark: "After I got started, I thought, if I was going to do it again, I would go at it on the square. I started out," he added, "before I thought." Thus instinctive logic won the day against forty-five years of special training.

If instinctive, however, this logic should be found almost as well developed in children as in adults. Accordingly, spicing the ball with candy or a small coin, several experiments were tried upon children from three to twelve years of age. In general the above statement was supported; but two of the number, aged respectively three and six, failed to show anything like the amount of search-logic possessed by most of the pigeons or the shepherd

dog. One of these, the devious path of a bright six-year-old Irish girl, is reproduced in Fig. 12. Lubbock's ants might be pardoned for smiling should they chance to see this tracing.

The search line of an intelligent dog is given in Fig. 11. His eyes were covered, but he evidently had a strong impression that the ball had been thrown in the direction I happened to be facing. Resemblance between this and tracings of a number of the pigeons is quite evident.

The bearing of the above upon the problem of search as exhibited by the homing pigeon requires no detailed statement. In a word, the pigeon uses a logic of search which is common to animals generally, and there is no evidence that he employs anything else. His power of rapid and prolonged flight makes it possible for him to spin his search lines over vast areas and so carry them beyond our vision and lift them into the realm of mystery.

In such cases the time consumed furnishes an important check. Of a large number of birds sent away by rail for longer flights, not one made the return trip in less time than would have enabled him to fly on the involute of a circle from the place of liberation. This refers to "first flights." The best time made was twenty-six miles in five hours and nine minutes. Three other birds liberated at the same time failed to return. Letting the distance to which a prominent landmark is visible be three miles, a fair estimate for pigeons with some training and over broken country, the least length of an involute of a circle which would bring a bird from a distance of twenty-six miles to within sight of the loft is two hundred and nineteen miles. In five hours it is not likely that the pigeon flew less than two hundred and fifty miles.

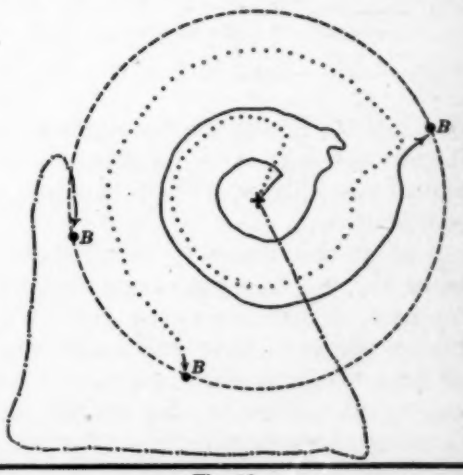

Fig. 10.

Three search lines, circular and rectangular types. + Starting point. The ball is shown at different points on ——, the 40 step circle. ——— Fence.

One thing which causes the search lines of the pigeons to swerve from the ideal curve of search upon a uniform field is that the field in their case is never uniform. A house of any kind, especially a red building, or, upon the lake, nearness to land,

furnish elements of greater probability and determine search in that direction. To obtain an ideal curve for a uniform surface it would be necessary to liberate the pigeon on a Dakota prairie or in mid-ocean, where no break in the landscape is visible even from an altitude of a thousand feet. It is not, however, difficult to find approximations to the ideal in the widening circles and the flights in different directions to be seen in Figs. 1 to 4.

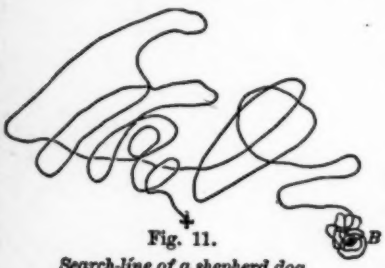

Fig. 11.
Search-line of a shepherd dog.
+ Starting point. B. Ball.

It may seem to some that in denying a "sense of direction" and affirming a logic is like jumping from the frying pan into the fire. The only thing to be said on this point is that we do find evidence for search-logic and no evidence for "direction-sense." And further, in the one case we explain the phenomena by something fundamental in animal life, which we do know something about; whereas on "sense-direction" grounds we are explaining the partially known by the absolutely unknown.

An instance of quite a different sort from the above stood in the writer's mind as almost conclusive proof of sense-direction powers for a number of years. It may be briefly stated as follows:

A large Maltese tomcat once joined, on his own invitation, an evening rowing party on one of the Wisconsin lakes. It was a sultry summer night, as dark as a moonless night can be. Not a breath of air was stirring. We rowed nearly due north, straight out toward the middle of the lake, which is something over two miles wide. For some time Tom purred and made himself generally agreeable from one end of the boat to the other; but at last he grew restless and extremely anxious to get home. He would climb out to the end of the boat and, stretching his head toward home, mew almost continuously. We amused ourselves for some time by turning the boat slowly round and round, first one way then the other, to see if we could throw Tom off his bearings; but all to no effect. Whether right side, left side, bow or stern, Tom was always on the part of the boat nearest home, and straining as far as he could in that direction. Fully a mile from any shore, how could he tell which shore was which? But few lights were visible, the lake is thickly wooded, and the cottages stand well back among the trees. Not one in the party could recognize the lights of our own group of cottages. And no one but myself and cat had any idea which way to go for home. For my part, I had kept an eye out for the north star. But what

did Tom do for his bearings? Could it be that through such inky darkness he could see enough of the shore to distinguish anything on it? This was easily tested. Taking a heavy blanket

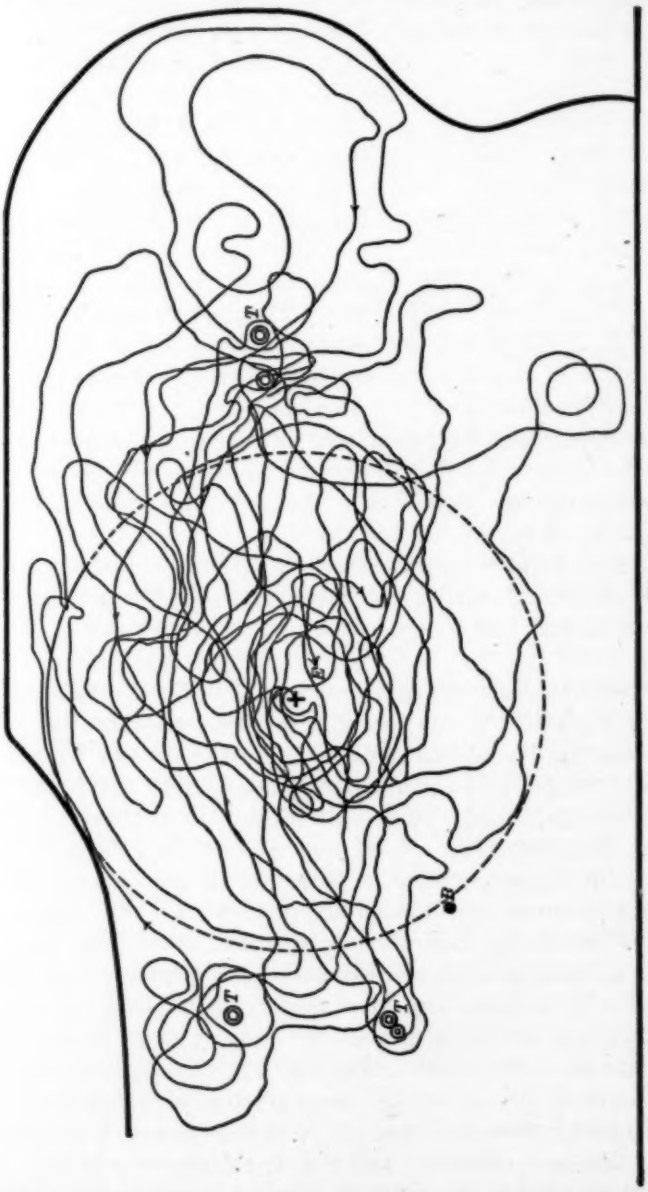

Fig. 12.
Search line of B. H., a 6 year old girl
+ Starting point. B, ball on 10 step circle.
T trees. E, terminus. Time, 75 minutes.

shawl, which was serving as cushion, we wrapped Tom up in a number of thicknesses of it and one of the party held him in her lap while the boat was slowly turned around. This was of no use. On being released Tom started, with never a mistake and without

the slightest hesitation, toward the end of the boat nearest home. To make doubly sure that vision was impossible, Tom was wrapped up and gently held flat in the bottom of the boat. This made no difference. Whether the boat was turned by a single stroke, as on a pivot, or rowed slowly around in a circle, the result was always the same. Tom went, without hesitation, invariably to the end or side of the boat nearest home.

Members of the party were blindfolded and required to guess whether the boat was turned or allowed to stand still, or was rowed in a straight line or in a circle; and it was an even chance whether they guessed right or wrong. Tom had a far better head for direction than any of us.

It was suggested that possibly a gentle current of air might be serving Tom as a direction-constant. This, however, could hardly have penetrated the shawl, and certainly not when in the bottom of the boat. Still, might not such a current be conveying odors imperceptible to man, but not to a cat? None of our number could feel the slightest breath of air on our faces, and even with the moistened finger held above the head, it was impossible to detect any flow of air. Might not then a wake of odor hanging in the air over our course serve as the needed direction-constant? This could hardly be, since we had rowed about so much that anything of the sort must have become thoroughly diffused.

Sight, smell, and touch would thus seem to be inadequate to explain the feat. Hearing still remains. But not a sound from any shore broke the silence. No town or city was near to furnish a roar, hum, or series of sounds of any sort. We could hear no bands of music, nor even the occasional bark of a dog. For minutes at a time we could hear absolutely no sound. And yet, may it not be that Tom heard every note some Tabby was making on the shore a mile away? If we were dealing with a sense as delicate as this, further experiment was useless. We had no means of stopping Tom's ears, and no microphone with which to explore the darkness for sounds inaudible to our ears.

The above explanation is open to serious objections. The chief of these, aside from such acuteness of hearing, is the fact that at no moment during the hour or more we were experimenting with him did Tom show the least doubt as to his direction. The auditory constant, therefore, must have been uninterrupted, and supposing it to have been the mewing of some cat, or cats, we all know what the possibilities are. At the time, the writer was quite convinced to the contrary, but several years afterward an incident occurred which threw the balance of probability strongly toward the side of the auditory explanation.

While hunting deer in Montana, I once lay on the top of a hill watching a doe as she kept guard while her two fawns were feed-

ing. The three deer were in about the middle of a level grassy plain fully half a mile from where I lay. I focused my field glasses on the group, and soon became much interested in the alertness of the doe. Not for an instant did she show the slightest relaxation of attention. Generally, under such circumstances, a deer is seen to sniff the air in every direction, but this time no air was stirring, and the main feature of the watching was the constant movement of the long ears. At a slight noise, occasioned by my change of position, a noise not even noticed by myself, I was surprised to see the doe start, turn about, and point her ears in my direction. After a minute's silence, her attention was attracted elsewhere, and this time I made the lowest possible "ahem!" Again both ears and head were directed toward me. And so in turn for an hour, I tried all manners of slight sounds, low whistles, snapping the fingers, tapping my rifle stock, scraping the grass with my foot; all were followed, with the precision of the response of a strychnized frog, with the attent turning of the ears in my direction. The writer at that time was not familiar with any special apparatus for the purpose, and so can give no exact measure of the sounds employed. I can only say, however, that they were so slight that, if a deer could hear them half a mile away over a grassy plain, it might be an easy matter for a cat to hear a moderately loud "mew" a mile away, over the surface of water on a still night.

It is not rare to find great differences in keenness of sense among different men. These differences become emphasized by use, as we find in the sight of the sailor or savage, or in the touch of the blind. There is every reason why we should expect to find such differences much more pronounced between different species of animals. So marked, in fact, do they appear that the temptation has always been to declare them differences in kind. Before doing this, we ought to make a beginning, at least, to learn the possibilities of the senses as they exist in different animals. So far as the writer has gone in this direction, he is content to conclude that they are using the ordinary senses, highly refined, it may be, by generations of development; and the every-day logic which tells man and animal alike that the shortest path between two points is a straight line.

In the course of his journeyings in the Pamirs, the Earl of Dunmore came upon a beautifully clear sheet of water, out of which the Yambulak River flows. It is surrounded on three sides by stupendous cliffs, rising sheer up two thousand feet from the water's edge, with one huge glacier standing out in bold relief in the middle of them, "which doubtless," he says, "gave the water the most beautiful emerald hue I ever saw." The altitude of the lake is 15,800 feet, and the summit of the Yambulak Pass beyond it is 16,530 feet high.

INCIDENTS OF CAMBODIAN LIFE.

By ADHÉMARD LECLÈRE.

THE Cambodian woman carries her child a-straddle of her left hip, with her arm passed round its little body. She rarely leaves it, except to attend to something in the house or the yard; and this custom of carrying the child thus is followed up so constantly that one shoulder of the woman finally becomes higher than the other. When the mother goes to the rice fields, or to the village, or so far that this method of carrying it becomes fatiguing, she puts the child into a shawl and carries it on her back. In the house, the baby sleeps on a mat, on which the mother has thrown an old *sampot* (cloth), so as to raise its head a little higher than the body, or in a shawl hung as a hammock, or in a hammock made of a quartered bamboo, the ends of which are whole. The child is naked, but when it is cold in the morning it is given a shawl or a piece of *sampot* for a covering, and is carefully covered at night. Boys go naked till they are six, seven, or eight years old, but after that age they put on a *sampot;* girls are dressed when they are four years old. In some parts of the country the children, otherwise nude, wear a small plate of ornamented silver in front. It is also a general custom to hang pieces of money, ancient or modern, from the neck, and rings of silver or gold on their arms and ankles. Mothers too poor to give them jewels tie a piece of cord that has been blessed by a wizard around their necks. The ears of girls are bored very early, sometimes even before they can walk, and cotton threads are inserted, to be replaced in time by gold or silver earrings. The heads of children are shaved often—to harden them, the Cambodians say—but at the age of three or four years a circular tuft is permitted to grow on the top of the head, and when the hair in this spot has reached a certain length it is bound and fastened with a pin of gold, silver, copper, or wood.

Cambodian children, it seems to me, are not as precocious as European children, favorable as the climate is to them. Thus we do not find in Cambodia (or in Annam, Tonquin, or Cochin China) babies beginning to walk in their tenth or ninth month, and I have never seen any who could speak correctly in their third year, although in France we have little gentlemen and young dames who are in their second year already very talkative and very important personages. The children of the Cambodians are generally pretty till they are about twelve years old, with more regular features than they will have afterward; and it is pleasant to find in them some of the resemblance to their Indian ancestors, which has been absorbed with the features of a more numer-

ous and less gifted race. The children have prodigious memories, and I have often been surprised at the facility with which, without giving themselves much trouble, they learn in a few months the Roman characters and French writing and language. The faculty of learning foreign languages persists in the adult; the grown men, our servants, persons living near us, learn enough of our language to make themselves understood, while we have to take nearly two years to learn, without study, as much as they. The children are very intelligent, but I have been assured, and am disposed to believe it, that their intelligence, if it does not remain stationary, becomes less active after their fifteenth year. It seems as if a little darkness came over their minds when their primitively pure features are deformed and they lose their atavistic resemblance to their ancestors.

They are docile, obedient, quiet in their sports, and very respectful to their parents. They are never seen presenting anything to their father with one hand, negligently or hurriedly, but well-brought-up children, observing well the old customs, offer the object requested with both hands, gracefully bowing. They do not eat with their father unless he invites them, but with their mother and her women, in whose charge they are. They do not sit with their father or on the same level, because it is proper for children to be always placed below their father. They have likewise a great respect for their mother, but it is more intimate than that for their father, who is also master of the house, and is designated by a word that means master and prince. Respect for the mother, while less demonstrative, is more durable; it continues in sons and daughters long after their marriage, and with grand mandarins and in the palace assumes a really touching appearance of deep veneration. I was told that the king never came into the presence of his mother without saluting her on his knees, and without offering her the homage which his mandarins offered to him.

At eleven years for the girls and thirteen years for the boys—or sometimes thirteen years for the girls and fifteen years for the boys, but never twelve or fourteen years, for years of even numbers are considered unlucky—the ceremony of cutting the hair is performed; that is, the shearing of the tuft which we have seen is tied and fastened with a pin. This ceremony of Brahmanic origin, a kind of sacrament instituted by Siva, which the Hindus call *kesenta*, takes place usually in the anniversary month of the child's birth, on the first day of the decrease of the moon, in the presence of all the relatives and the friends and clients of the family. The festivals already mentioned in connection with the cutting of the hair are repeated in full, but this time it is the turn of persons of higher importance to perform the ceremony. This festival is the festival of puberty. From its celebration the child

lets his hair grow as he desires to wear it. The girls cease to play and laugh with the boys, observe a more strict and graver walk, and more usually keep to the house.

Betrothals take place, in the presence of both families, one or two years before the marriage. They consist of a repast participated in in common by all the connection, and in the proclamation of the engagement which the two families have made to unite their children. As the diviners have named the most favorable day for the betrothal, they also designate the most suitable one for the celebration of the marriage. This ceremony takes place, like the former one, in the presence of both the contracting families, the kindred, and the neighbors. It includes presents made by the groom to the parents of the bride, the offer of betel and areca nuts, the invocation of ancestors, and the *chang day* or binding of the wrists, a curious ceremony which all the parents perform by attaching cotton threads around the left wrist, in token, I suppose, of the bonds which will hereafter exist between the members of the two families. Besides this a present of *sampots*, silver bars, or money is made by the friends of the groom to the mother of the bride, in consideration of the care she bestowed on her daughter in her infancy. This has been improperly, perhaps, styled the price of the girl; if not a proof of her purchase by the groom, it is certainly a relic of the customs of a period when the woman was bought by the one who married her, and the price paid to the mother. I say to the mother, not to the father, because the present is in reality made to her, and not to the head of the family; a very important fact, which with others that I shall adduce attests to the existence in the past of the matriarchate among the Khmers.

I find traces of this state of society in this fact, that the price of the "nursing milk," as it is called, is paid to the mother; and also in the much more lasting and profound respect had by the son for his mother, and in the general and uncontested principle that the woman put away by her husband has the right to take her children with her. I might add, too, in support of this view that it is the custom, always observed, for the father not to consent to a marriage which the mother opposes, and not to pledge a child without the consent of its mother; then there is the instinctive horror, much more marked than when the father is the victim, which Cambodians feel at the thought of a child beating its mother. One of the most conclusive proofs appears in the word for cousin-german, which when analyzed means brother-grandmother, or brother by the same grandmother, but never brother by the same grandfather. This affords an almost incontestable trace of an ancient social *régime* when relationship followed the female line.

The Cambodian woman occupies a dignified position in the house of her husband. He owes her respect and gives it, and is not rude or violent in her presence. He can put her away, but she can also claim a divorce at law. She can go to law without the consent of her husband, when she must be supported by a relative, or, if she has none, by a respectable neighbor. If she is summoned to court, she can oblige her husband to go with her, under penalty, if he fails to go, of his losing his rights over her; and she can leave him without his having any right to complain or to claim reparation. He can pawn her or sell her as a slave if she consents, but he can not dispose of himself in such way without her approval. The woman can have but one husband, and he can not take a second wife or any additional one without the consent of his first wife. The first wife is called the first wife, the second the middle wife, and the third the end wife; those that follow are concubines. They are all hierarchically subordinated one to the other, but the great wife, the true wife, is mistress of the house, and the others are only her followers and servants. If one of these encroaches upon her prerogatives, she can punish her; if she seeks to seduce the husband and supplant the first wife in his heart, she can call her guilty rival before the court and get judgment against her. The first wives sometimes select the other wives for their husbands, often choosing such as will be agreeable companions to themselves; and women are numerous who have been able to exert such influence over their husbands or exercise such power in the house as to prevent the introduction of any other wives.

Cambodian maidens rarely go astray, and infanticide is absolutely unknown in the country. Mothers are anxious to have children, and are not afraid of any number of them. A woman who has no children after several years of marriage is unhappy over the fact, and her fellow-women sympathize with her for it.

The people are brave, willing to run considerable dangers for a small reward, and are valiant in action; but they are superstitious, and believe in ghosts, evil spirits, witches, and witchcraft. They offer worship to genii and invoke them, good and bad alike, when they are afraid or in need. It is not rare to find in the corner of a rice field a little straw mat inclosing a fragment of a sculptured prayer from some ancient Khmer monument, or simply an ordinary stone. They believe that the *arac* dwells in this stone, give it homage, and burn fragrant sticks before it, which they plant in a piece of banana stem, or a small basin, or in half a cocoanut filled with sand. They also render a secret worship to *lingams* derived from the Brahmanic epoch which have been concealed for centuries in the depths of natural grottoes, without knowing what these stones represent.

The Khmers believe in unlucky places, which one can not inhabit or cultivate without exposure to death; in places haunted by evil spirits, which one can not visit without perishing; in stones or statues which one can not touch without falling sick; and places which one can not pass without making an offering. There are in the province of Kampot a mountain at the foot of which the Chinese dies who attempts to pass it, and a defile where it is necessary to alight from one's horse or carriage and cast an offering of branches upon a cup placed at the fork of two roads, saying, "I offer thee a parasol." A statue of a woman of the Brahmanic period stands on a river island in the province of Sambaur, before which women can not present themselves, but which men are permitted to caress in order to insure the fidelity of their wives.

Many women and children wear cords which they buy of the witches, in order to preserve them from certain maladies; and from these sometimes hang little leather cylinders which are believed to be very effective. In certain provinces of Upper Cambodia characters are tattooed on the breast as preservatives against attacks by the tiger and panther, and against snake bites.

The Cambodians are usually pleasantly disposed, but very revengeful for injuries. Theft is common, but less so than in Cochin China. Assassination does not excite any great degree of attention or cause any deep remorse in the murderer. They bear pain with much courage; but illness reduces their energy to a very low degree. Prisoners condemned to death by decapitation march courageously to punishment, smoking their last cigarette, without bravado and without weakness.

The paddy gathered and deposited in the granary is protected by a stone for which they have a superstitious regard; and they employ the *achars*, the religious *literati* of the village, to read prayers and invocations over the store.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

THE latest report of the directors of convict prisons in England gives satisfactory evidence that serious crime is perceptibly diminishing throughout the country. Thus, during the five years ending in 1859, when the population of England and Wales was 19,257,000, the sentences to penal servitude numbered 2,589. The years 1885 to 1889 showed the much lower total of 945; the population then being 27,830,179. Since that period a further decrease has been registered. A reduction in the number of young convicts has been remarked. Even as late as 1887 it stood at 3·2 per cent of the whole prison population. In 1892 it was 1·2 per cent. These observations agree with the statement that the diminution in the whole amount of criminality is mainly attributable to a decrease in the number of young offenders, while the proportion of older delinquents has increased.

THE ICE AGE AND ITS WORK.

By ALFRED R. WALLACE, F. R. S.

ERRATIC BLOCKS AND ICE-SHEETS.—(*Continued.*)

II.

WE must now consider briefly the distribution of erratics in North America, because they present some peculiar features and teach us much concerning the possibilities of glacier motion.

An immense area of the Northeastern States, extending south to New York, and then westward in an irregular line to Cincinnati and St. Louis, is almost wholly covered with a deposit of drift material, in which rocks of various sizes are imbedded, while other rocks, often of enormous size, lie upon the surface. These blocks have been carefully studied by the American geologists, and they present us with some very interesting facts. Not only are the distances from which they have been transported very great, but in very many cases they are found at a greater elevation than the place from which they must have come. Prof. G. F. Wright found an enormous accumulation of bowlders on a sandstone plateau in Monroe County, Pennsylvania. Many of these bowlders were granite, and must have come either from the Adirondack Mountains two hundred miles to the north, or from the Canadian Highlands still farther away. This accumulation of bowlders was seventy or eighty feet high, and it extended many miles, descending into a deep valley one thousand feet below the plateau in a nearly continuous line forming part of the southern moraine of the great American ice-sheet.

On the Kentucky hills, about twelve miles south of Cincinnati, conglomerate bowlders containing pebbles of red jasper can be traced to a limited outcrop of the same rock in Canada to the north of Lake Huron, more than six hundred miles distant, and similar bowlders have been found at intervals over the whole intervening country. In both these cases the blocks must have passed over intervening valleys and hills, the latter as high or nearly as high as the source from whence the rocks were derived. Even more remarkable are numerous bowlders of Helderberg limestone on the summit of the Blue Ridge in Pennsylvania, which must have been brought from ledges at least five hundred feet lower than the places upon which they now lie. The Blue Ridge itself shows remarkable signs of glacial abrasion, in a well-defined shoulder marking the southern limit of the ice (as indicated also by heaps of drift and erratics), so that Mr. Wright

concludes that several hundred feet of the ridge have been worn away by the ice.

The crowning example of bowlder transportation is, however, afforded by the blocks of light gray gneiss discovered by Prof. Hitchcock on the summit of Mount Washington, over six thousand feet above sea-level, and identified with Bethlehem gneiss, whose nearest outcrop is in Jefferson, several miles to the northwest, and three or four thousand feet lower than Mount Washington.

These varied phenomena of erratic blocks and rock striations, together with the enormous quantity of bowlder clay and glacial drift spread over the whole of the Eastern States, terminating southward in a more or less abrupt line of mounds having all the characteristics of an enormous moraine, have led American geologists to certain definite conclusions in which they all practically agree. It may be well first to give a notion of the enormous amount of the glacial *débris* under which a large part of the Eastern States is buried. In New England these deposits are of less thickness than farther south, averaging from ten to twenty feet over the whole area. In Pennsylvania and New York east of the Alleghanies the deposits are very irregular, often sixty or seventy feet thick and sometimes more. West of the Alleghanies in New York, Pennsylvania, and Ohio the thickness is much greater, being often one hundred and fifty or two hundred feet in the wide valleys, and forty or fifty feet on many of the uplands. Prof. Newberry calculates that in Ohio it averages sixty feet deep over an area of twenty-five thousand square miles.

The direction of the striæ and of the traveled bowlders together with the form of the great terminal moraines show that there must have been two main centers of outflow for the ice-sheet, one over Labrador, the other over the Laurentian Highlands north of Lake Superior. The southern margin of the drift may be roughly represented by portions of circles drawn from these two points as centers. The erratics on the summit of Mount Washington show that the ice-sheet must have been a mile thick in its neighborhood, and much thicker at the centers of dispersion, while the masses of drift and erratics on plateaus two thousand feet high near its southern boundary indicate a great thickness at the termination. The Laurentian plateau is now about two thousand feet above the sea-level, but there are numerous indications from buried river channels, filled with drift and far below the sea, which lead to the conclusion that during the Ice age the land was much higher. That snow can accumulate to an enormous extent over land of moderate height when the conditions are favorable for such an accumulation is shown by the case of Greenland, the greater part of whose surface is a vast

plateau of ice flowing outward by numerous glaciers into the sea. The center of this plateau where Dr. Nansen crossed it was over nine thousand feet above sea-level, and it may be very much higher farther north. It, therefore, seems probable that the great American ice-sheet was, at least, as high, and perhaps much higher, and this would give sufficient slope for the flow to the southern border. Of course, during the successive stages of the glaciation there may have been numerous local centers from which glaciers radiated, and during the passing away of the Ice Age these local glaciers would have left striæ and other indications of their presence. But so much of the area covered by the drift—all, in fact, south of the New England mountains and the Great Lakes—is undulating ground, hill, valley, and plateau of moderate height, that here all the phenomena seem to be due to the great confluent ice-sheet during the various phases of its advance and its passing away.

Sir Henry Howorth, in his very instructive work already quoted, denies the existence and even the possibility of such ice-sheets as those here indicated as having occurred in North America and Europe. He maintains that ice of the requisite thickness could not exist, as it would be crushed or liquefied by its own weight; and further, that if it existed it could not possibly move over hundreds of miles of generally level country, passing over hills and valleys and carrying with it, either on its surface or in its lower strata, the enormous quantity of bowlders, gravel, and clay which we find everywhere overlying the present surface of the ground. No doubt the difficulty does seem an enormous one, but I think that it can be shown to be not so great as it seems; and it is certainly by no means so insuperable as that of the apocryphal floods, or "waves of translation" as they have been called, to which he imputes the phenomena. He asks us to believe in one or more gigantic waves sweeping over Eastern North America, carrying bowlders to the summit of Mount Washington, nearly six thousand feet high, scattering others over an area which is roughly one thousand miles from east to west and six hundred from north to south, and in its course producing those wonderful striæ, grooves, and furrows in the rocks photographed in the American reports, and the enormous extent of smooth and rounded rock surfaces that is found over this wide area. Besides these there are two other phenomena absolutely inconsistent with a diluvial agency. One is the enormous deposits of fine compact clay bearing rounded and scratched stones thickly scattered through it, utterly unlike any deposit produced by water, which would necessarily leave the stones hundreds of miles behind the place to which the fine mud would be carried. The other is the existence of well-defined heaps, mounds, and ridges of gravel and

bowlders, forming the terminal moraine of the ice-sheet. This is exactly similar in general form and structure to the moraines left by the old Alpine or North British glaciers, and if the former could have been produced by a flood so could the latter. But the American terminal moraine runs across the country almost irrespective of its contour, and is often as well marked on plateaus as in valleys and on the intermediate slopes. Moreover, this moraine often lies on the southern slope of the hills draining toward the Mississippi Valley; and we are asked to believe that a flood vast enough to carry gravel and rocks for hundreds of miles to such a position, left them all stranded on a slope down which it must have been rushing with increased velocity and without hindrance toward the Gulf of Mexico! So far as I know, Sir Henry Howorth is absolutely alone among living writers in his diluvial theories, and I only give this brief statement of their overwhelming impossibilities because his book is so interesting, and his assertions that his theory explains *all* the facts are so confident and so often repeated that they are likely to confuse the judgment of readers who have not paid special attention to the subject.

Returning to the main question, of the possibility of glaciers or ice-sheets moving over long distances of generally level ground with intervening hills and valleys, there is an important piece of evidence, the bearing of which appears to have been overlooked by objectors. The former existence of the great Rhone glacier carrying erratics to the slopes of the Jura from beyond Geneva on the southwest to Soleure on the northeast, is universally admitted. This glacier passed out of the gorge between the Dent du Midi and the Dent de Morcles, and a little below St. Maurice enters on the alluvial plain which extends to the lake. From this point to Geneva, a distance of about sixty miles, may be considered a level plain, the descent into the lake being balanced by the ascent out of it. Yet it is admitted that the glacier *did* move over this distance, since erratics which can be traced to their source on the left of the valley below Martigny are found near that city. But the main part of the glacier curved round to the right across the Lake of Neufchâtel, and extended at least as far as Soleure, a distance of about ninety miles. To do this it must have ascended five or six hundred feet to the country around Fribourg, and before reaching Soleure must have passed over a hill three or four hundred feet higher. Yet on the flanks of the Jura above Soleure there are erratics which have been carried on the surface of the glacier from the east side of the valley below Martigny, and close to Soleure itself there are remains of a terminal subglacial moraine of compact bowlder clay. Sir Charles Lyell describes this as—

an unstratified mass of clay or mud, through which a variety of angular and rubbed stones were scattered, and a marked proportion of the whole were polished and scratched, and the clay rendered so compact, as if by the incumbent pressure of a great mass of ice, that it has been found necessary to blow it up with gunpowder in making railway cuttings through part of it. A marble rock, of the age of our Portland stone, on which this old moraine rests has its surface polished like a looking-glass, displaying beautiful sections of fossil shells, while occasionally, besides finer striæ, there are deeper rectilinear grooves, agreeing in direction with the course in which the extinct glacier moved according to the theory of M. Guyot before explained.*

It is evident that, to have produced such effects as are here described, the glacier must have extended much beyond Soleure, and have been very thick even there. It thus proves to demonstration that a glacier *can* travel for a hundred miles over a generally level country, that it *can* pass over hills and valleys, and that, even near its termination, it *can* groove, and grind, and polish rocks, and deposit large masses of hard bowlder clay. And all this was done by a single glacier issuing from a comparatively narrow valley, and then spreading out over an area many times greater than that of its whole previous course. In this case it is clear that such a vast mass of ice, constituting a veritable ice-sheet on a small scale, could not have derived its motion solely from the push given to it by the parent glacier at St. Maurice. Neither could gravitation derived from the slope of the ground have affected it, for it passed mostly over level ground or up slopes, and its termination at Soleure is actually nearly two hundred feet higher than its starting point at the mouth of the valley below St. Moritz! There remains as a cause of motion only the slope of the upper surface of the glacier, the ice slowly flowing downward, and, by means of its tenacity and its viscosity on a large scale, dragging its lower portion still more slowly over the uneven or upward sloping surface. This mode of motion will be discussed later when dealing with the origin of lake-basins.

No doubt at this epoch of maximum glaciation the ice-sheet extended over the whole country between the Bernese Alps and the Jura, and the downward flow of the lateral glaciers along the valley of the Sarine, Aare, and other rivers flowing toward Soleure greatly assisted the general onward motion. But the fact remains, and it can not be too strongly insisted on, that here we have a veritable ice-sheet moving over hill and valley, carrying on its surface quantities of erratic blocks, rounding, striating, and polishing the rocks over which it passed, and with the material thus crushed and ground away forming great deposits of bowlder clay, much of which still remains, although enormous quantities

* The Antiquity of Man, fourth edition, p. 349.

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Returning to the main question, of the possibility of glaciers or ice-sheets moving over long distances of generally level ground with intervening hills and valleys, there is an important piece of evidence, the bearing of which appears to have been overlooked by objectors. The former existence of the great Rhone glacier carrying erratics to the slopes of the Jura from beyond Geneva on the southwest to Soleure on the northeast, is universally admitted. This glacier passed out of the gorge between the Dent du Midi and the Dent de Morcles, and a little below St. Maurice enters on the alluvial plain which extends to the lake. From this point to Geneva, a distance of about sixty miles, may be considered a level plain, the descent into the lake being balanced by the ascent out of it. Yet it is admitted that the glacier *did* move over this distance, since erratics which can be traced to their source on the left of the valley below Martigny are found near that city. But the main part of the glacier curved round to the right across the Lake of Neufchâtel, and extended at least as far as Soleure, a distance of about ninety miles. To do this it must have ascended five or six hundred feet to the country around Fribourg, and before reaching Soleure must have passed over a hill three or four hundred feet higher. Yet on the flanks of the Jura above Soleure there are erratics which have been carried on the surface of the glacier from the east side of the valley below Martigny, and close to Soleure itself there are remains of a terminal subglacial moraine of compact bowlder clay. Sir Charles Lyell describes this as—

an unstratified mass of clay or mud, through which a variety of angular and rubbed stones were scattered, and a marked proportion of the whole were polished and scratched, and the clay rendered so compact, as if by the incumbent pressure of a great mass of ice, that it has been found necessary to blow it up with gunpowder in making railway cuttings through part of it. A marble rock, of the age of our Portland stone, on which this old moraine rests has its surface polished like a looking-glass, displaying beautiful sections of fossil shells, while occasionally, besides finer striæ, there are deeper rectilinear grooves, agreeing in direction with the course in which the extinct glacier moved according to the theory of M. Guyot before explained.*

It is evident that, to have produced such effects as are here described, the glacier must have extended much beyond Soleure, and have been very thick even there. It thus proves to demonstration that a glacier *can* travel for a hundred miles over a generally level country, that it *can* pass over hills and valleys, and that, even near its termination, it *can* groove, and grind, and polish rocks, and deposit large masses of hard bowlder clay. And all this was done by a single glacier issuing from a comparatively narrow valley, and then spreading out over an area many times greater than that of its whole previous course. In this case it is clear that such a vast mass of ice, constituting a veritable ice-sheet on a small scale, could not have derived its motion solely from the push given to it by the parent glacier at St. Maurice. Neither could gravitation derived from the slope of the ground have affected it, for it passed mostly over level ground or up slopes, and its termination at Soleure is actually nearly two hundred feet higher than its starting point at the mouth of the valley below St. Moritz! There remains as a cause of motion only the slope of the upper surface of the glacier, the ice slowly flowing downward, and, by means of its tenacity and its viscosity on a large scale, dragging its lower portion still more slowly over the uneven or upward sloping surface. This mode of motion will be discussed later when dealing with the origin of lake-basins.

No doubt at this epoch of maximum glaciation the ice-sheet extended over the whole country between the Bernese Alps and the Jura, and the downward flow of the lateral glaciers along the valley of the Sarine, Aare, and other rivers flowing toward Soleure greatly assisted the general onward motion. But the fact remains, and it can not be too strongly insisted on, that here we have a veritable ice-sheet moving over hill and valley, carrying on its surface quantities of erratic blocks, rounding, striating, and polishing the rocks over which it passed, and with the material thus crushed and ground away forming great deposits of bowlder clay, much of which still remains, although enormous quantities

* The Antiquity of Man, fourth edition, p. 349.

must have been carried away by the rivers to the lowlands of Europe and to the sea. The fact is therefore demonstrated, and is implicitly admitted by the most conservative of glacialists, that in this case an ice-sheet *has* moved onward over a hilly plateau for nearly a hundred miles, even when its terminal moraine is at a higher level than its exit from the mountain valley where it had its origin.

It will now be well briefly to sketch the distribution of erratic blocks in Great Britain, and the conclusions to be drawn from them as to the former existence of an ice-sheet under which the greater part of our islands was buried.

Every mountain group north of the Bristol Channel was a center from which, in the earlier and later phases of the Ice age, glaciers radiated; but many facts prove that during its maximum development these separate glacier systems became confluent, and formed extensive ice-sheets which overflowed into the Atlantic Ocean on the west, and spread far over the English lowlands on the east and south. This is indicated partly by the great height at which glacial striæ are found, reaching to twenty-five hundred feet in the Lake District and in Ireland, somewhat higher in North Wales, and in Scotland to nearly thirty-five hundred feet; but also by the extraordinary distribution of erratic blocks, many of which can be traced to localities whence they could only have been brought across the sea. The direction of the glacial striæ and of the smoothed side of ice-worn rocks also indicate that the shallow seas were all filled up by ice. The Outer Hebrides, for example, are all ice-ground from the southeast and east, showing that the deep channel of the Minch was filled up, and that the Scotch ice-sheet flowed completely over the islands. On all sides of Ireland, except the southern coast, the ice flowed outward, but on the northeast the flow was diverted southward, and on the extreme north, westward, by the pressure of the overflowing ice-sheet of Scotland which here encountered it. In like manner, the ice-marks on the east coast of Ireland and the west coast of Wales are diverted southward by the mutual pressure of their ice-sheets, which, together with that of the west of Scotland, filled up St. George's Channel. That such was the case is further proved by the fact that the Isle of Man is ice-ground in a general direction from north to south, and to the summit of its loftiest mountains, which rise to a height of over two thousand feet. This could only have been done by an ice-sheet flowing over it, and this view is further supported by some most remarkable facts in the dispersal of *local* erratics. These are always found to the south of the places where they occur *in situ*, never to the north; and, what is still more noteworthy, they are often found

far above the native rock. Thus, bowlders of the peculiar Foxdale granite are found about fourteen hundred feet higher than the highest point where there is an outcrop of this rock.

The Scotch ice-sheet flowed outward on all sides, but on the east it was met by the southward extension of the great Scandinavian ice-sheet. On the extreme north the meeting of these two ice-sheets resulted in a flow to the northwest which glaciated the Orkney Islands, while the Shetlands, much farther north, received the full impact of the Scandinavian ice alone, and are therefore glaciated from the northeast. The dividing line of the Scotch and Scandinavian ice-sheets was in the North Sea, not far from the east coast of Scotland; but farther south, at Flamborough Head and Holderness, the latter impinged on our coast, bringing with it enormous quantities of Scandinavian rocks. Many years ago Prof. Sedgwick described the cliffs of bowlder clay at Holderness as containing "an incredible number of smooth round blocks of granite, gneiss, greenstone, mica slate, etc., resembling none of the rocks of England, but resembling specimens derived from various parts of the great Scandinavian chain." These are mixed, however, with a number of British rocks from the north and west, indicating the meeting ground of the two conflicting ice-sheets. Similar blocks occur all along the coast as far as the cliffs of Cromer in Norfolk. Across the peninsula of Flamborough about two miles west of the lighthouse there is a moraine ridge containing a few Scandinavian bowlders, but mainly composed of British rocks. These latter consist of numerous carboniferous rocks from the north and northwest, together with many of Shap granite —a peculiar rock found only on Shap Fell in the eastern side of the Lake District, together with a few of Galloway granite. These facts, it will be seen, add further confirmation to the theory of great confluent ice-sheets indicated by the ice-markings upon the various groups of mountains, while it is hopelessly impossible to explain them on any theory of local glaciers, even with the aid of submergence and of floating ice.

The study of our British erratics has been assiduously pursued for many years past by a committee of the British Association; and by means of a map showing the chief facts collected up to this date, kindly furnished me by Mr. Percy F. Kendal, secretary of the committee, I am able to give a brief sketch of the more important of the phenomena, and their bearing on the extent and motion of the British ice-sheet. The general reader may be informed that great numbers of rocks are so local and so characteristic, often being confined to a very limited district or to a single mountain, that the origin of a considerable portion of the erratics can be ascertained with the greatest certainty.

Taking first the Shap granite, which has already been men-

tioned as occurring at Flamborough Head, we find that it has been carried northward as far as the Solway Frith, and eastward to the Eden Valley in great quantity and over a wide area. Thence can be traced a line of bowlders of this rock over the high plateau of Stainmoor into the valley of the Tees, and onward round the coast by Scarborough to Holderness, while a branch descends southward along the valley of the Ouse to York. Coming back to its source on Shap Fell, a train of bowlders of the same rock has been traced southward in a curving line, passing the east side of Morecambe Bay near Lancaster, and thence sparingly southeastward to near Whalley. Along the same line are found bowlders of peculiar granites from Eskdale and Buttermere, marking the line of junction of the northern ice-sheet with that which filled up the Irish Sea and pressed inward between the glaciers of Cumberland and North Wales. This is indicated by the fact that south of this line are scattered immense quantities of erratics, both from the southwest of Scotland and the Lake District, spreading over the whole of the low country as far as Bridgnorth and Wolverhampton, and eastward to the Derbyshire highlands. These same erratics are found round the north coasts of Wales and part of Anglesea, showing how the iceflows divided on either side of the mountain mass of North Wales.

The center of the great glacier sheet of North Wales appears to have been over the Arenig Mountains, whence erratics of a peculiar volcanic rock have been traced to the north and east, mingling with the last-described group; while a distinct train of these Welsh erratics stretches southeastward to the country west of Birmingham.

In the Isle of Man are found many erratics from Galloway and a few from the Lake District. But the most remarkable are those of a very peculiar rock found only on Ailsa Craig, a small island in the Frith of Clyde, and a single bowlder of a peculiar pitchstone found only in the Isle of Arran. The Ailsa Craig rock has also been found at Moel Tryfaen, on the west side of Snowdon, and more recently at Killiney, County Dublin, on the seashore.*

The case of the bowlders in the Isle of Man, which have been carried nearly eight hundred feet above their source, has already been mentioned, but there are many other examples of this phenomenon in our islands; and as they are of great importance in regard to the general theory of glacial motion a few of them may be noted here. So early as 1818 Mr. Weaver described a granite block on the top of Cronebane, a slate hill in Ireland, and several hundred feet higher than any place where similar granite was to be found *in situ;* and he also noticed several deposits of limestone

* Nature, vol. xlvii, p. 464.

gravel in places from three to four hundred feet higher than the beds of limestone rock which are from two to ten miles off. *Débris* of red sandstone is also found much higher than the parent rock. Bowlders of Shap granite, Mr. Kendal tells us, have passed over Stainmoor by tens of thousands, and in doing so have been carried about two hundred feet above their source; and the curious Permian rock, "Brockram," has been carried in the same direction no less than a thousand feet higher than its highest point of origin.* In Scandinavia there are still more striking examples, erratic blocks having been found at an elevation of forty-five hundred feet which could not possibly have come from any place higher than eighteen hundred feet.† We thus find clear and absolute demonstration of glacier ice moving up-hill and dragging with it rocks from lower levels to elevations varying from two hundred to twenty-seven hundred feet above their origin. In Switzerland we have proof of the same general fact in the terminal moraine of the northern branch of the Rhone glacier being about two hundred feet higher than the Lake of Geneva, with very much higher intervening ground. As it is universally admitted that the glacier of the Rhone did extend to beyond Soleure, all the *a priori* objections to the various cases of rocks carried much higher than their origin, in America, the British Isles, and Scandinavia, fall to the ground. We must either deny the existence of the ice-sheet in the great Swiss valley, and find some other means of accounting for the traveled blocks on the Jura between Geneva and Soleure, or admit that the lower strata of a great glacier *can* travel up-hill and over hill and valley, and that the ice-sheets of the British Isles, of Scandinavia, and of North America merely exhibit the very same characteristics as those of Switzerland, but sometimes on a larger scale. We may not be yet able to explain fully how it thus moves, or what slope of the upper surface is required in order that the bottom of the ice may move up a given ascent, but the fact of such motion can not any longer be denied.

The facts thus established render it more easy for us to accept one of the latest conclusions of British glacialists. A great submergence of a large portion of the British Isles during the Glacial period, or in the interval between successive phases of the Glacial period, has long been accepted by geologists, and maps have been often published showing the small group of islands to which our country was then reduced, the supposed subsidence being about fourteen hundred feet. The evidence for this is the occurrence, at a few spots, of glacial gravels containing marine

* Wright's Man and the Glacial Period, p. 154.

† James Geikie's Great Ice Age, second edition, p. 404.

shells in tolerable abundance, the most celebrated being at Moel Tryfaen, on the west side of Snowdon, at a height of more than thirteen hundred feet. Shell-bearing drifts have also been found near Macclesfield at a height of over eleven hundred feet, and to the east of Manchester at between five and six hundred feet elevation. Others have since been found on Gloppa, a hill near Oswestry. The fact that the shell-bearing gravels of Moel Tryfaen are nearly forty feet thick shows that, if they are due to submergence, the land must have remained stationary at that level for a considerable period of time, and there would probably be other stationary periods at lower levels. Yet nowhere in the valleys or on the hill slopes of Wales, or the Lake District, or in the English lowlands are there any of the old beaches or sea cliffs, ormarine deposits of any kind, that must have been formed during such a subsidence and which can hardly have been everywhere cleared away by subsequent glaciation. Another difficulty is that the shells of these drifts are such as could not have lived together on one spot, some being northern species, others southern, some frequenting sandy others muddy bottoms, some which live only below tidal water while others are shore species. And, lastly, they are very fragmentary, only a small percentage of entire shells being found.

In consequence of these various difficulties it was suggested by the late Mr. Belt that the great Irish Sea ice-sheet had carried up a portion of the sea-bottom imbedded in its substance, perhaps containing deposits of shells of various periods and thus explaining the intermixture of species as well as their fragmentary condition. The fact that bowlders and pebbles from Scotland, Ailsa Craig, and Cumberland have been found in the Moel Tryfaen beds almost amounts to a proof that they were so uplifted; and a recent search has shown that in the other localities where marine shells have been found in drift at great elevations similar foreign rocks occur, rendering it almost certain that the same ice-sheets which have distributed foreign erratics so widely over our country, and which in doing so *must* have passed over the sea-bottom, have in a few cases carried with them a portion of that sea-bottom, and deposited it with the erratics in the places where both are now found. A full discussion of this point, with replies to various objections, by Mr. P. F. Kendal, will be found in the volume already quoted; and he has recently adduced a fresh argument against "the great submergence" in the fact that, if it ever occurred, our lowlands must for a long time have formed the bottom of a sea two hundred fathoms deep, yet not a single shell characteristic of that depth has yet been discovered in the drift.* The cumulative

* Wright's Man and the Glacial Period, pp. 167–175. Also Geological Magazine, November, 1892, pp. 491–500.

evidence against the submergence is now almost, if not quite, conclusive.

In the brief outline now given of the facts of glacial geology bearing upon the former existence, the thickness, extent, and motion of ice-sheets, it has only been possible to treat the subject very broadly, omitting all those details and minor difficulties which can not be discussed within the limits of a popular article. My object has been to explain the nature and amount of the converging evidence demonstrating the existence of enormous ice-sheets in the Northern hemisphere, to serve as a basis for the discussion of the glacial origin of lake-basins, which will form the subject of another article.—*Fortnightly Review.*

A CENTURY OF THE TELEGRAPH IN FRANCE.

By WALTER LODIAN.

IT is one hundred years ago (the 22d of March, 1792) since a young man named Claude Chappe presented himself at the bar of the Legislative Assembly. He carried there a secret vocabulary composed of nine thousand nine hundred and ninety-nine words, represented by some numbers, and destined to be transmitted by a system of visual telegraphy by means of a machine carrying the signals from station to station.

The examination of the machine was promptly confided to a committee, which reported in favor of its adoption, and a little after, the Convention voted the funds necessary to the establishment of a trial line.

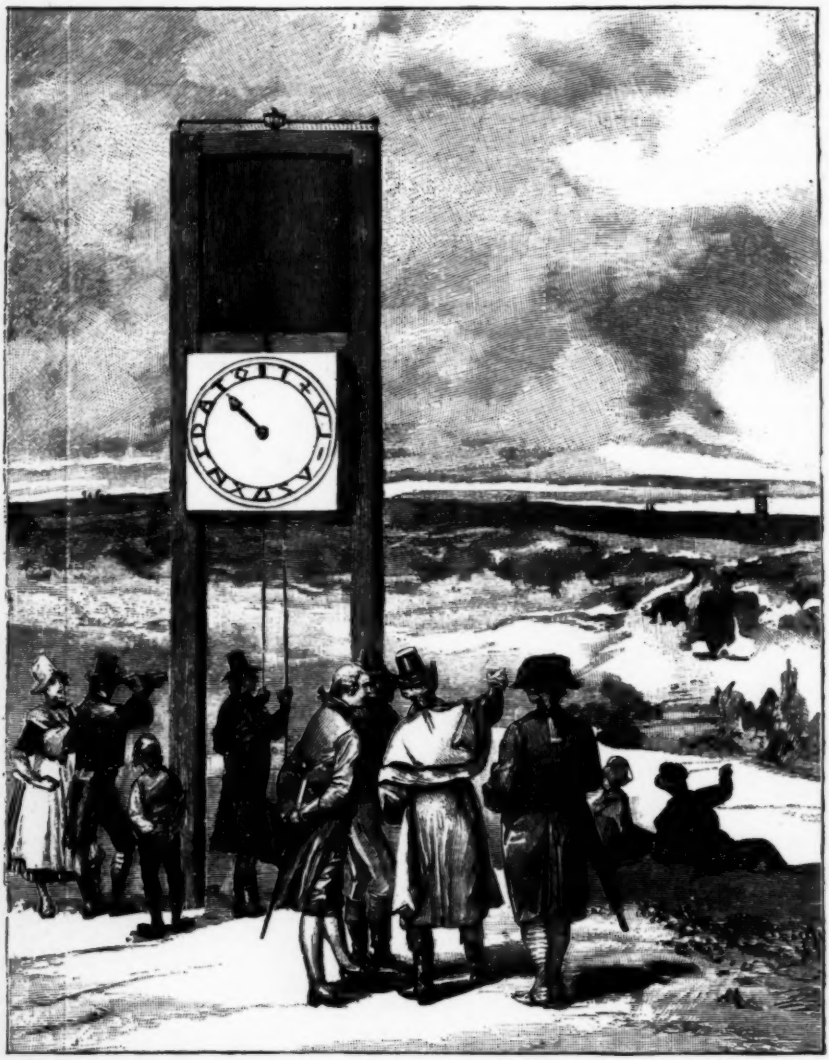
It is this memorable event—the origin of the most marvelous discovery of our times—which the telegraphic people have recently *fêted* as solemnly as possible.

On this occasion it has appeared to us useful as well as interesting to retrace the history of telegraphy in France, to note briefly the successive stages and the perfecting of the telegraphs which have transformed the world.

Some essays in telegraphy were made in modern times, notably at the end of the seventeenth century, by Dr. Hooke, an English physician, who made service of an apparatus consisting of some characters of a sufficient size for being perceived at a distance, each one corresponding to a letter of the alphabet.

Under the reign of the fourteenth Bourbon clique, a *savant* (G. Amontons), who became later on member of the Academy of Sciences, took up the study of the problem of aërial telegraphy. Highly interesting was the result thereof. Fontenelle, the litera-

rian, has recounted these experiences. This was, according to him, a very ingenious thing, permitting to make known all that which one would at a great distance, in little time—for example, from Paris to Rome in three or four hours—and this even with-



THE FIRST TELEGRAPHIC APPARATUS.

out the news being given out in all the space between the two cities. This preparation, so paradoxical and so chimeric in appearance, was executed in a little stretch of country, once in presence of monseigneur and once in presence of madame. The secret consisted in disposing, in several consecutive posts, some young men who, by some long-view telescopes, having perceived cer-

tain signals of the preceding post, transmitted them to the following, and always thus in succession, and these different signals were so many letters of an alphabet of which they had not the cipher then at Paris and at Rome. The greatest distance seeable by the telescopes made the distance between the posts, of which the number was to be the least that was possible, and, as the second post made some signals to the third, as soon as they were seen made at the first, the news was found carried to Rome in almost as little time as it needed for making the signals at Paris.

The government of Louis XV did not occupy themselves with what it considered a mere plaything, and the inventor, discouraged, renounced his project. Thus was relinquished, some two hundred years ago, a project in telegraphy which was about as rapid, if not rapider, than the slow-coach message from Rome to Paris of the present day, which actually takes half a dozen hours or so for the delivery from domicile to domicile.

CHAPPE.

In 1788 Dupuis experimented in turn with an alphabetic telegraph, and Linguet, on his side, was also thus occupied about the same epoch.

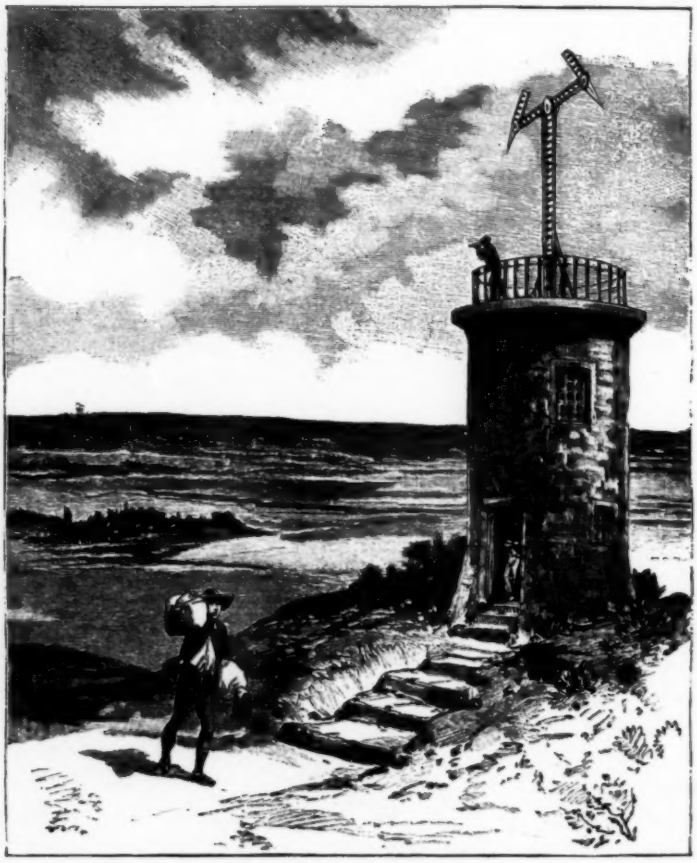
The idea was, therefore, so to say, in the air when appeared Claude Chappe, to whom the entire globe is indebted in reality for the invention of the telegraph. This is one of the events the most memorable in the history of humanity.

Claude Chappe was born at Brulon (department Sarthe) in 1763. His father gave him a classical instruction of the most approved kind. The studies of Claude, commenced at the college of Joyeuse, at Rouen, were terminated at the seminary of La Flèche; as to his four brothers, they were placed in an establishment a trifle away from this latter town, and this has caused the supposition to some of his biographers that Claude Chappe had conceived the idea of his telegraph in order to be able to communicate with his brothers. It is to-day demonstrated that this is nothing but a legend.

Chappe studied the sciences from his early youth. Physical science specially attracted him, and he published at the age of twenty years some very remarkable researches.

We have said that he submitted to the Legislative Assembly,

the 22d of March, 1792, his invention. He read his petition himself, submitting "a discovery which he thought useful to the public welfare," and presenting a facile means of communicating rapidly at great distances all that which might be the object of a correspondence. He could from them transmit the recital of a fact at night as well as at day over a space of forty



AËRIAL TELEGRAPHY, 1793.

miles in less than forty-six minutes, and in a manner almost as rapid at a distance very much greater.

The Assembly accepted the tender of the machine, sent the petition to the examination of the Committee of Public Instruction, and admitted Chappe to the honors of the sitting.

Unfortunately for him, the commissioners could not attend any experiment; the ignorant populace destroyed the machine which he had constructed at Belleville. The unlucky inventor had, therefore, to demand aid and protection, with indemnity for the necessary repairs.

The Convention, which had succeeded to the Legislative Assembly in the meanwhile, resent the petition to the committee, but it was not until the 1st of April, 1793, that the deputy Romme mounted to the tribune for there to give reading of an admirable report, of which the following is a little excerpt, describing briefly the invention:

"The citizen Chappe offers an ingenious means of writing in the air by displaying some characters very trifling in number, simple as the straight lines of which they are composed, very distinct between them, of a rapid execution, and sensible at great distances. To this first part of his procedure he uses a stenography used in the diplomatic correspondences. We have made some objections to him; he has foreseen them, and has responded victoriously. He removes all the difficulties which may present themselves on the land over which is directed his line of correspondence; a sole case resists his means: this is that of a very thick fog which comes over the north, in the aqueous countries, and in winter; but outside this very rare case (which resists equally all the processes known) they will have recourse momentarily to the ordinary means. The intermediary agents employed in the procedures of the citizen Chappe can not in any manner betray the secret of his correspondence, because the stenographic value of the signals will be unknown to them. Two verbal processes of the municipality of the Sarthe attest the success of this procedure in an essay which the author has made for them, and permitting the author to advance with some assurance that with his procedure, the dispatch which reported the news of the taking of Bruxelles had been transmitted to the Convention and translated in twenty-five minutes."

[That was, note, a hundred years ago. Bruxelles is six hours by express from Paris. The speed of transmitting over the aërial telegraph of then was much quicker than by the electric telegraph of to-day, for at present it takes much longer than half an hour—generally an hour—to remit an ordinary telegram from an office in the Belgian capital to a domicile in Paris.]

In the same sitting the National Convention rendered a decree authorizing the trials, and naming three commissaries—Lakanal, Daunou, and Arbogast. A violent opposition was soon manifested, but Lakanal sustained Chappe with all his authority, and the inventor could construct a veritable telegraphic line of thirty-five kilometres, starting from the lake St.-Fargeau, at Ménilmontant.

Finally, on the 12th of July, 1793, took place the definite trials, which were for Chappe a veritable triumph. He received the title of engineer-telegraphist, with the appointments attributed to lieutenants of artillery.

The telegraph was thus finally officially founded.

But on the 23d of January, 1805, the unfortunate Claude Chappe, tortured by a cancer in the ear, committed suicide by throwing himself in the pits of the hôtel des télégraphes, rue de Grenelle-Saint-Germain 103. He was aged only forty-two years.

A Military Post, 1794.

A stone which is still in the court of the hotel, near the central post, bears this simple inscription: "To Claude Chappe."

In 1844 the aërial network had in France a stretch of five thousand kilometres, and comprised five hundred and thirty-four stations. It was henceforth not to increase, because the first trials of the electric telegraph were taking place in Albion, and had created an immense sensation.

An order of the 23d of November, 1844, opened an extraordi-

nary credit of two hundred and forty thousand francs for making experiments. The works commenced promptly on the railroad of Paris to Rouen, and on the 18th of May, 1845, the first dispatches by the electric telegraph took place.

The first telegraphic apparatus used was the patent of Foy-Bréguet. On the 20th of November, 1850, a law was made permitting private persons to send dispatches over the wires (the state hitherto was the only party using it) after rigorous investigation of their identity. The tariff was established at three francs per dispatch of one to twenty words; over, twelve centimes per myriametre. On the 31st of December, 1851, was inaugurated the submarine cable from Calais to Dover.

The number of dispatches in 1851 was 9,014. The length of the telegraphic lines in operation attained at December 31, 1851, 2,133 kilometres.

In 1854 was created the general direction of telegraphic lines. The writing apparatus of Morse substituted the fugitive signals of the Foy-Bréguet system, and the telegraphic system went from 7,175 kilometres to 9,244 kilometres of lines.

The year 1860 was signaled by an important fact. A conditional agreement was concluded with Mr. Hughes, professor of physics at New York, the celebrated inventor of the printing apparatus, which was definitely adopted in 1861 by the French.

The decree of the 13th of August, 1864, lowered from one franc to fifty centimes the tariff on dispatches simply circulating in Paris. The happy consequences of this liberal measure surpassed the most optimistic prophecies. They resulted in the following figures, comment on which is superfluous. Number of dispatches in January, 1864, 577; in December, 1864, 11,250.

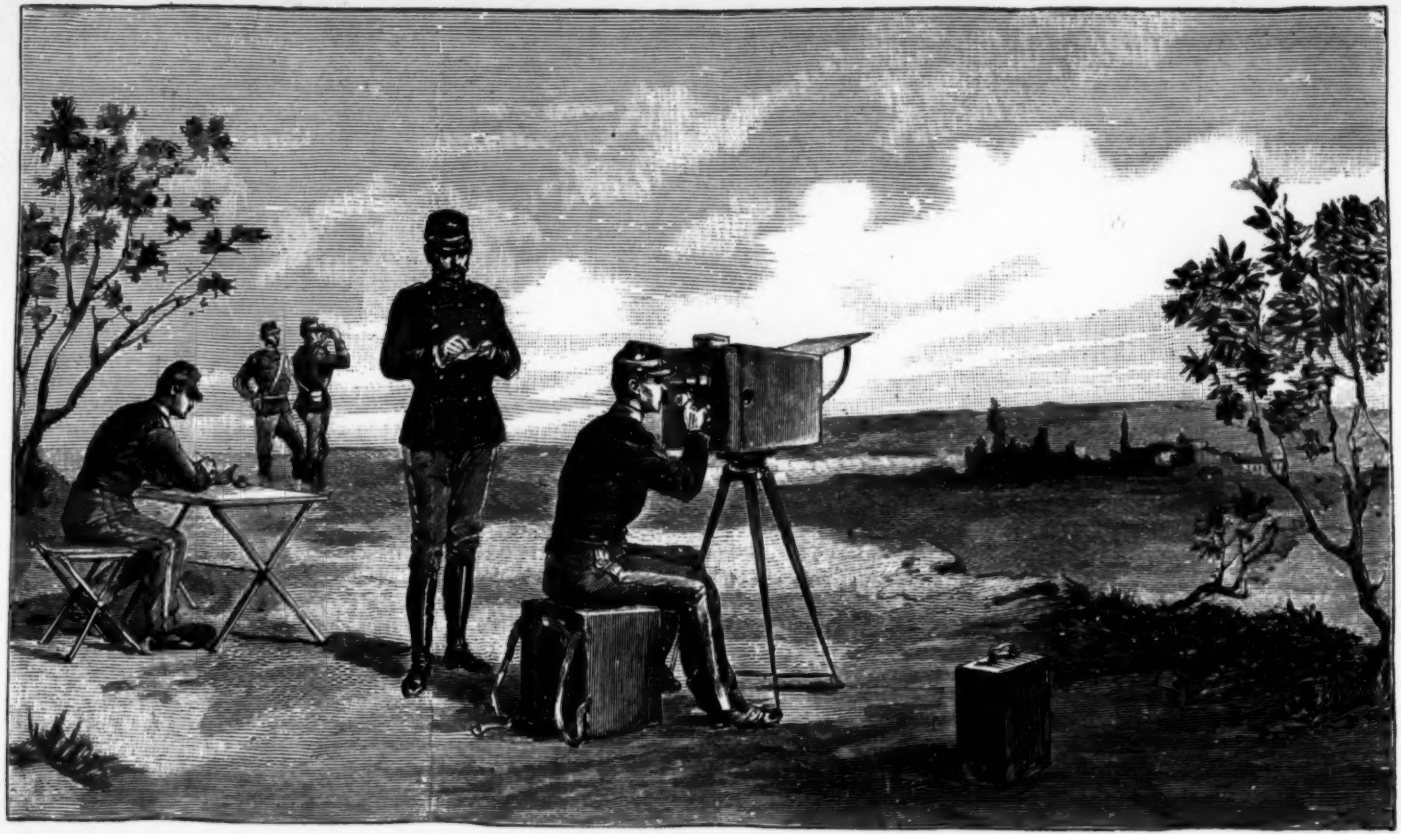
The year 1865 was marked by one of the most considerable events in telegraphy—the reunion at Paris of the first international telegraphic conference, due to the initiative of France.

Two years later the first pneumatic line appeared in Paris. With the advent of the third republic, and up to within the last years, prodigious developments have been made in telegraphy.

Military telegraphy, or optical telegraphy with the aid of the sun, has also advanced. A description of these apparatus would run into too much space. It will suffice to state that two telegraphists are necessary for managing an optical apparatus. One reads the signals aloud as he perceives them, the other writes them down. There are two classes of instruments, telescopic and "campaign."

Here are the last statistics of the telegraphic bureau in France for one year: Number of inland telegrams, 26,084,742; international, 5,318,265; total, 31,403,007.

Development of the telegraphic system: Overhead lines, 86,440



MILITARY OPTICAL TELEGRAPHY.

kilometres of line, 264,980 of wire; ordinary subterranean lines, 1,719 line, 15,168 of wire; long-distance subterranean, 4,524 line, 30,237 wire; submarine, 6,004 line; private lines, 3,293 line, 6,512 wire; railroad telegraphs, 12,588 line, 106,653 wire. At end of 1890 the overhead lines alone had in all France covered some 115,000 kilometres.

Telegraphic bureaus in France, about 9,000. They use 12,750 Morse instruments, 993 Hughes, 25 Wheatstone, 58 Baudot, 1,155 Cadran, 1 Meyer, 951 diverse; total, 15,932.

The poste central (as it is locally termed) and the telegraphic service of Paris has an exceptional importance, which is easily explained. Paris, head and heart of France, is, in effect, the center from whence all radiates and where all converges. It is at the central post of telegraphs of Paris (rue de Grenelle 103) where are managed all the telegraphic dispatches exchanged between Paris and the departments or abroad, as well as a great number of those which the different towns exchange between themselves. The poste central is exclusively a bureau of transmissions; no dispatch is disposed there directly, and it does not distribute any directly. The service is performed by about five hundred men and four hundred women. The approximate daily average of the number of telegrams expedited by the poste central is 36,250, and by all the bureaus of France 67,187.

One can conceive that a personal staff so numerous must be installed in some vast and specially furnished rooms. Two new halls have been constructed quite recently and opened for business. Their installation leaves something to be desired; the light penetrates there badly at night; they are illuminated by electricity. One of these halls is occupied by the men telegraphists, the other by the lady operators. The 362 apparati of diverse nature in service at the poste central are grouped in each one of these halls, following a methodical order based on the regional classification.

It is known that the apparati of the system Baudot are the most frequently used in telegraphy. They serve the cities of Marseilles, Havre, Lille, Bordeaux, Toulouse, Lyon, Brest, Caen, Clermont-Ferrand, and Nantes. They permit several employés to work at two, four, and even at six on the same wire, thanks to the ingenious application of the division of time realized by M. Baudot, engineer of the administration.

Two brigades share the service with the men, same as with the females, an alternating service which leaves them a little liberty. The employées (mark, the word with two final *e*'s is feminine) while at work are all dressed in black blouses to preserve their dresses from the oil stains liable to result from close contact with the apparatus. They are allowed to do, when their post is free, a little work in crocheting or in tapestry.

OPERATORS' ROOM IN THE GREAT TELEGRAPH EXCHANGE, PARIS.

On some great tables are installed the apparatus with all their accessories; each employée has allotted to her a space about ninety by ninety centimetres. Before each one there is a bar with three spikes, where they have to place separately the dispatches for abroad, the province, and Paris. In the middle of the hall is a bureau for the direction of the dispatches; two factors are attached to each section, one for unspiking the dispatches and carrying them to the direction, the other for distributing the dispatches on the posts. There is furthermore an elevator near the direction for mounting or descending the telegrams, because the men's hall, situated above, possesses all the wires connecting with the great cities of France as well as to abroad.

The basement is assuredly one of the most interesting parts of the poste-central. There are found some vaulted cellars devoted to the nine thousand elements of piles in service; in other places one will see some dynamo-electric machines, refilling pumps, etc. This is certainly not one of the least interesting features, that of seeing steam engines become the auxiliaries of telegraphy.

These machines work, on one part, the compressing pumps destined to run the Hughes apparatus and the dynamo-electric machines necessary for the production of the electric light. They work equally a dynamo-electric apparatus (an auto-regulator), which an agent of the central post, P. Picard, has had the ingenious idea to invent for replacing the piles.

Between them, the French writers, K. Fichot and H. Meyer, have managed to produce a fairly creditable account on the occasion and descriptively historical of the centenary of the foundation in France of the telegraph. The Parisians have celebrated the event, and while so fêting the centennial of the aërial telegraph they were almost at the same time, in a way, celebrating the golden jubilee of the introduction into Gaul of the electric telegraph, which was established at Paris just close on fifty years ago.

The interesting and curious paper of the Gaulois literarians above named will not be noticed in the French technical press (or, at least, it is not believed it will be); therefore an advanced translation is forwarded for the edification of English-speaking readers. In this rendering the purity of the original has been faithfully preserved as much as possible, even unto preserving some of the idiomatic peculiarities of expression of the vernacular.

It will be seen that the present summary is moderately complete,—detailing the introduction of the telegraph, some rather surprising comparisons; then the advent and progress and a few statistics of the present-day electric telegraph, description of the Paris great central bureau, etc.

AN ILLUSTRATIVE CHAPTER ON LEGAL DEVELOPMENT.

By WILLIAM W. BILLSON.

THE evidences are abundant that primitive man had no conception of ownership as distinguished from or as subsisting independently of possession. He recognized, no doubt, that one in possession of an object had a right to defend and maintain his advantageous position. If, however, the possession were lost, whether by accident, violence, or theft, the result, in the primitive judgment, was the permanent extinguishment of all relation between the object possessed and its former possessor, unless there was an immediate reseizure; somewhat as now one's claim upon wild animals, birds, or bees in his possession is forever lost by their escape, unless saved by prompt pursuit and immediate recapture. Even after the establishment of courts and the reinstatement of dispossessed persons by their authority, the relief was afforded, not upon any theory of subsisting ownership in the person dispossessed, but by way of redress for the personal grievance which he was perceived to have suffered—as now, even in the acknowledged absence of proprietary rights, we justify a person in recovering an eligible position in a street or other public place from which he has been rudely crowded by another. The legal protection of property is, historically considered, a mere extension of the protection afforded by law to the person, every wrong having been originally thought of as in the nature of a personal injustice only. The conception of ownership, instead of being the cause or historical basis of remedies for the recovery of possession, is in fact the tardy outgrowth of impressions produced upon the mind by the habitual application of those remedies as a mode of relief against injuries long regarded as purely personal.

It might be supposed that if men were ever unacquainted with the idea of ownership apart from possession it must have been in such prehistoric ages as now scarcely to admit of verification. On the contrary, no circumstance in history, perhaps, has been more prolific of legal doctrine. No finer instance can be found of that strange gift of immortality, by virtue of which the crudest of barbaric notions may live, eternal in their effects, in the polished doctrines of the most refined systems of law; no more instructive example of the evolution of the most abstruse legal refinements from the simplest germs of thought; no more impressive exhibition of the enormous inherent difficulties of legal progress, which arise from the fact that the advanced ideas of later generations, can from the nature of the case, take effect only through an adaptation of the rude and intractable forms and

proceedings inherited from a remote past. As we proceed along these lines of observation we shall incidentally fall in with interesting evidence that much of the legal complexity which we are wont to ascribe to the dark and crooked casuistry of lawyers is in the nature of an inevitable survival of customs, methods, and institutions born of the excusable mental incapacity of our foremost fathers.

So plentiful in the history of our own land are the materials for a short study of this peculiarity of early thought and its sequences that recourse will be here had to these alone, although the subject is susceptible of similar though perhaps less striking illustration from the land law of the Romans, and indeed to some extent from almost any system of law, with reference to either real or personal property.

Lawyers of a later day have experienced no little difficulty in appreciating that Britton, St. Germain, and others of our earliest legal writers spoke advisedly when they defined a freehold interest in land (which bore to our early law the relation occupied in modern law by the word ownership) as meaning the "*possession of the soil.*" Yet the accuracy of this definition at the date of its origin finds the most ample and varied attestation in our authentic legal history. The word "owner" was unknown to our early land law. That one who wrongfully dispossessed another of his land, succeeded to the estate or interest in the land, was one of the most deeply rooted doctrines of the common law from the time when the idea of an estate in lands was first conceived. The dispossessor acquired that which he could sell and transfer, and that which upon his death would descend to his heirs. On the other hand, the person dispossessed had nothing left which any one could buy or which in the event of his death his heirs could inherit. It was almost the middle of the present century before in England this ceased to be the law. The natural effect of this doctrine, as the reader will no doubt be prepared to believe, was to make the law of dispossession one of the most interesting and prolific branches of our earlier jurisprudence. It became directly and indirectly the subject matter of a surprisingly large proportion of judicial decisions, and of a correspondingly large part of the early legal commentaries, and, of course, continued to be expounded and developed in its detailed applications long after the disappearance of the mental and social conditions that gave it birth. Among the common-law applications of the rule were the following:

A wrongful usurper of the possession was considered to take in every case the entire title, or, in legal parlance, the *fee*, even though he disclaimed an intention to take more than a life estate, for it was said that he could not qualify his own wrong. If ap-

purtenant to the land seized there were easements or rights of enjoyment over other adjacent lands, the intruder by his possession of the principal estate became legally entitled to enjoy such easements. The estate of the person dispossessed was in the language of the law "turned into a right." This "right," although untransferable to any one else, could be released to the intruder, and by such release the estate of the intruder, which was tortious or wrongful, became rightful. But, although words of inheritance were generally necessary to convey more than an estate for life, no such words were necessary in a release to a dispossessor, since the fee or entire estate was already in him, though wrongfully. For the same reason a release to the intruder for a year, or even for a day, was as good as though to him and his heirs forever, since the fee, or entire title, which he already had, though wrongfully, could not, it was said, be curtailed by a deed without entry—that is, without a transfer of the possession. And upon the ground that the estate was already in the intruder, an instrument executed to him by the person ousted, although it purported to give and grant the described premises, was held to operate only as a confirmation of the estate already vested in the usurper. So, while the intruder was in possession, no action could be maintained against him for trespass, or for the value of crops harvested by him, or for other similar profits; nor could such actions be maintained even after the rightful claimant had recovered possession, except by recourse to a legal fiction (invented to avert such injustice), by which for such purposes a temporarily dispossessed person was, after recovery, construed to have been continuously in possession.

The right to dispose of lands by will was first introduced in the reign of Henry VIII by a statute which declared that "all persons having any manors, lands, or tenements may give and dispose of them by last will." In construing this statute, it was held, in harmony with the foregoing doctrines of the common law, that only those persons *had* lands who were in possession of them, and that dispossessed persons, therefore, had nothing upon which a will could operate. Such was the law in England until changed by statute in 1838. Such also had been the recognized law before the statute of Henry VIII in those counties where by local custom the power to will had previously existed.

But, although a person by being ejected from his lands lost all his estate in them, he was not without rights of redress. If he acted promptly he was entitled to recover his lost ground, and, until prohibited by the statute of Richard III, he might enlist and employ whatever forces were necessary for that purpose. The time within which this right of personal recovery, or, as it

was called in the law, right of entry, could be exercised was at first very short.

In the time of Bracton (thirteenth century) it was only four days, that being deemed sufficient time within which to arouse the neighbors and organize an invading force. The right was afterward recognized as continuing a year and a day. Still later it might be exercised during the lifetime of the intruder. Originally entry could be made only as against the intruder personally, not against one claiming under him. Afterward it could be made against the intruder's first successor, then against his second successor, still later against others still more remote, etc. It was about the time of Lord Bacon before a re-entry could be made after the lands, by death of the intruder, had passed into the possession of his heir. It was the wrongful character of the intruder's estate that was supposed to justify re-entry, and it was deemed inadmissible to treat the estate as wrongful in the hands of the heir, upon whom it had been cast by operation of law without any wrongdoing on his part.

The legal effect of a re-entry was to reinvest the ousted person with his lost estate. Originally it was no doubt necessary for him to eject the wrongdoer and resume complete control. It was soon perceived that where two persons were upon the same piece of ground, each claiming possession, he should be deemed to have the possession who had the right to it, and this principle was variously applied with salutary effects. The law was still further mitigated by considering that the effects of re-entry were attained and the estate of the intruder divested by even a temporary entrance of the ousted person upon the land under a claim of right, provided such entry was repeated at least once a year, thus keeping up publicly a continual claim to the land. And it came to be deemed sufficient as an entry if, when the ousted person could not go upon the land for fear of violence, he went as near to it as he safely could and publicly claimed it in the presence of witnesses. By these acts of re-entry and continual claim the person dispossessed could revive and keep alive his estate in the land, so as to have a conveyable and inheritable interest, although the intruder still remained in the actual possession; for, by construction of law, the entry and continual claim were treated as amounting to a recovery of the possession. The law also came to be so relaxed that where one, by the same intruder, was dispossessed of several tracts of land in one county, a re-entry upon one, in the name of all, was treated as a good entry upon all.

It is not surprising that under these circumstances there were few branches of our early law which experienced a more luxuriant growth than those that related to rights of entry, to descents that took away rights of entry, and to the making of continual claim.

If re-entry was not made within the time limited by law, the right to make it became derelict and was extinct; but there still remained the right of recovery by action at law. These actions and their procedure, and the amount of proof exacted, varied according to the length of time the intruder had remained in possession, whether and how many times the possession had been sold or transferred by or under the intruder, and so forth. Into their details it would be unprofitable to go. One who had simply a right to recover lands by action was not only destitute of anything transmissible to his heirs or to a purchaser, but had nothing which could be reached by an act of attainder. It is a noteworthy fact in this connection that our common law has never provided, either as to real or personal property, any form of action for litigating title or right of property independently of possession—a curious circumstance, unmistakably attesting that our legal remedies took form before the conception of property as distinct from possession had received practical recognition in our law.

It was, however, indirectly through its bearing upon modes of conveyance that the primitive view of property right made its deepest impression upon our law. It is manifest that when men dealt in possession only, there could not be two opinions as to the mode of effecting a sale or transfer of it. The only conceivable way was for the purchaser to take the seller's place as actual custodian; hence the universal prevalence in early societies of this mode of conveyance. Even when the theory was well advanced that the possessor of an object had an interest or estate in it, or a title to it, such interests were regarded as inherent in the possession and as inseparable from it, and therefore as passing with it and as being otherwise intransmissible. How, then, could such rights be transferred except by the manual delivery of the object? Even though there were a deed or a written or oral contract, its only function was to evidence an intent to abandon the possession in favor of another, and it was still only through the assumption of the actual possession by such other that he succeeded to the advantages resigned by the maker of the deed.

It is possible, but not certain, that during the later Anglo-Saxon period of our history this mode of conveyance had already been outgrown, and that property was then transferred by deed or charter alone, perhaps by reason of contact with Roman civilization. Be this as it may, the original mode of conveyance was, as a feature of the feudal law, so effectually resumed or continued upon the advent of the Normans that, except by means of judicial proceedings, real or feigned, the common law of England has never provided any other mode of directly transferring the entire estate in land than the solemn and public delivery of possession in the presence of the assembled neighbors, known in legal phrase

as the "livery of seisin," the word "livery" meaning delivery, and the word "seisin" meaning possession.

Although from a comparatively early day delivery was, from evidential considerations, usually accompanied by a deed, no writing was necessary until so made by the statute of Charles II; and the livery of seisin, though gradually simplified and softened into a symbolic ceremony, was indispensable to a common-law transfer of complete title until abolished by the statute of Victoria.

As already pointed out, this exclusive mode of conveyance was the natural result of the failure of early society to recognize any estate in lands which did not rest upon subsisting possession.

There are occasions upon which the possessor of lands desires to at once invest another with an estate in them which shall not commence in enjoyment or possession until a future day, as by now conveying A an estate in lands to take effect in possession when he shall become of age or marry, or upon the death of his father.

The tendency to create such future estates, representing as it does a natural desire which has always operated with more or less force since the idea of estates in land first obtained, has at times been greatly stimulated by English social and political conditions. Nor have such estates ever been deemed objectionable from the standpoint of public policy. It will be observed, however, that they are hard to reconcile with the doctrine that there can be no estate without possession, and hence no transfer of estate without transfer of possession. If, for example, in the case above supposed, possession were withheld from A, he would, in the light of that doctrine, fail to acquire any estate wh tever. If, on the other hand, possession were immediately delivered, he would get a present estate rather than a future. To what extent, then, was it possible to create future estates consistently with the ancient notion that without possession there could be no estate? This apparently simple question proved to be of almost incredible difficulty. Centuries of forensic discussion and adjudication were required for such a solution of it as the interests of society seemed to require. The answer, when complete, constituted the bulk of the marvelously complex law of remainders and executory devises.

So great was the social pressure in favor of future estates that there were doubtless points at which the reasoning was somewhat strained in order to overcome the almost insuperable resistance of the old notions respecting possession—slight deflections from the true line of logic being one of the indispensable agencies for adapting early law to the exigencies of later society. Yet the intention was to recognize future estates only so far as they were compatible with the established doctrine that an estate unsup-

ported by possession was impossible; and the question of compatibility was so closely reasoned through all its possible ramifications that there are few minor topics in any science that have elicited a more searching analysis, or which present a greater mass of subtle distinctions.

Of the body of abstruse rules thus evolved, it will be impossible within the limits of this paper to convey any adequate conception. It may be explained, however, that the door through which future estates were admitted into our law was the theory that the perpetual right of enjoyment implied from possession was an entire estate, which, by words used at the time of delivery, could, in point of time, be carved up into a number of fractions, to be successively enjoyed by different persons; and that as all these persons combined took only one entire estate, a single delivery would suffice for all, the taker of the first fraction being construed to receive the possession on behalf of all. Thus if delivery of land to A were accompanied by declaration or deed to the effect that A should have it for a term of years, then B for his life, the remainder of the estate after B's death to go to C and his heirs forever, these future estates to B and C were deemed valid, because B and C were regarded as in on the possession delivered to A.

This theory was countenanced only upon the ground that the total of the several fractional estates, thus created by a single act, was precisely equivalent to the one perpetual and uninterrupted right of enjoyment, which could be conferred upon one person by a single delivery. Any proposed future estate which could not be justified by a strict application of this theory was legally impossible. Hence, if by the terms of the delivery, or by reason of any subsequent contingency, the several fractions were not, or ceased to be, the exact equivalent of one entire estate, the future estates either never arose, or forthwith collapsed. There could, therefore, be no future estate, unless supported by a prior and present estate created by the same act; and each fractional estate must be such as to take effect in possession immediately upon the determination of the next preceding estate; otherwise it was void, and necessarily involved all succeeding estates in the ruin.

This stringent limitation arose into great importance, and indeed became the source of a large part of the law of future estates, when at a later day, upon grounds unnecessary and perhaps difficult to reproduce, it was held permissible to create future estates, doubtful or contingent as to the time when, or persons in whom, they should vest. Thus delivery might be made to A for his life, then to go for life to B's eldest son (not yet born), then forever to C and his heirs. Here it was a matter of contingency when, if ever, B would have a son. If A died before the birth of

such a son, all the subsequent estates collapsed, because, upon the ground already noticed, there could be no intermission, however short, between the successive estates. So, in the case supposed, it was possible for A, at any time, by his own act in voluntarily surrendering his own life estate, to destroy the future estates supported by it.

The great injustice and confusion of titles which flowed from this feature of the law finally led to the device of designating in cases of contingent future estates, trustees, in whom it was provided the estate should vest for the time being, in the event of the determination of a prior estate, before the contingency had happened, upon which the next succeeding estate was to take effect.

It was the *livery of seisin* which also set in motion and gave direction to that curiously complicated succession of ideas and legal devices which, during a period of more than four hundred years, made up the eventful and withal romantic history of uses, or, as they are now called, trusts—a history which at one time or another has had vital points of contact with nearly all the legal, political, religious, and domestic relations of life. That which made the use the nondescript but marvelously popular and mercurial thing that for centuries it was, was the tenacity with which the common-law courts adhered to their doctrine that, because the livery of seisin was not made to the beneficiary of a use, he took nothing which could be regarded as property, or which could be charged with the burdens or liabilities of property; that in fact "he had no more to do with the land than the merest stranger in the world"; while at the same time his every claim of control over the land was regularly enforced by courts of equity. Again, to the entanglement of the common law of possessions with the equitable law of uses, which was brought about in the middle of the sixteenth century through certain expressions in the statute of uses, and which gave rise to such obscure questions as the character of the seisin which was necessary under the statute to feed or serve uses, are directly traceable the most subtle distinctions of the law of springing and shifting uses and powers, words which, though the unprofessional reader may not fully understand, he may safely assume to stand, together with remainders, for all that was and is most abstruse and intricate in our law.

So it was the *livery of seisin* which, either directly, or indirectly through the law of uses, gave color and form to all the methods of conveyance, which through common-law devices or statutory provision were by strangely circuitous methods gradually substituted for it in the transfer of lands. The impossibility of compressing into this paper an adequate review of the developments which our subject underwent in connection with uses and convey-

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ancing makes it necessary to reserve that interesting chain of events for future consideration.

That the early law took no cognizance of ownership apart from possession was strikingly exhibited in the view which it took of inheritances. The estate of a possessor in lands was palpably terminated by his death. Yet his heir acquired no estate in the lands except by entering into the possession. If the heir died before entry, the lands went, not to his heir, but to the next heir of the ancestor who died in possession. In like manner, though one had received a deed of lands, yet if he died before entering into possession, he was deemed not to have acquired any estate, and consequently left nothing which his heirs could inherit, or of which his widow could have dower. And so it was, although he had actually entered into the possession under a deed, unless he had been publicly invested by the ceremony of *livery of seisin*.

It was among the miscellaneous corollaries of the *livery of seisin* that it was impossible for a landlord to sell his interest in the land without the concurrence of his tenant. The tenant being in possession, the landlord could only make *livery of seisin* to the purchaser by arranging with the tenant to temporarily retire, so that he, the landlord, could take the possession and deliver it, after which the tenant would resume possession under the new owner. In this and a variety of other ways the *livery of seisin* entered into the law of attornment.

We have remaining space only for casual reference to some of the processes, in addition to those already mentioned, by which the old notions and customs, which have been our theme, were gradually displaced or assimilated by modern legal conceptions. The idea of possession was gradually enlarged, so that one who had been in the actual possession was deemed to continue in it until it was seized by another, even though the property were in fact vacant.

Delivery, which at first must be made on the land, was afterward permitted to be made in presence of the neighbors at any place in sight of the land, and later at public places even more remote; and delivery of one tract might be made for several tracts in the same county; but in none of these cases did the estate pass until, in pursuance of such constructive deliveries, possession had been actually taken. So it became the custom to substitute a symbolic for an actual delivery, as by delivering a turf from the land or a key of the house. And so there came a time when, if one had bought and paid for land from another, who then refused to make *livery of seisin*, courts of equity would specifically enforce the agreement by compelling the delivery.

The celebrated statute of uses, 27 Henry VIII, opened up the way for conveyances without delivery. Into these newly opened

channels the conveyancing of the kingdom largely flowed, and the *livery of seisin* dropped into comparative desuetude. By later statutes, principally of the present reign, the ceremony and many of its related rules have been finally abolished. It was never practiced to any considerable extent in this country, which was not colonized until after the statute of uses.

Although the idea that there could be no estate in land without possession was so inextricably interwoven with the doctrines of the common law that escape from its meshes was impossible except by resort to legislation, the popular conceptions upon the subject, being comparatively unhampered, underwent necessarily a much more rapid change, so that in the popular sense or judgment interests in land, independently of the possession, existed centuries before it was possible for them to receive legal recognition. Finally, even to the most technical of lawyers, the old view came to seem like scarcely more than a legal fiction. In its direct applications it has now almost disappeared from our law. Its *effects* are simply ineffaceable. The time will never be when the legal doctrines of the English-speaking race will not still present numberless peculiarities of structure inherited from this prolific old juristic root.

THE BEAVER EATER.

By HORACE T. MARTIN, F. Z. S., Etc.

A VOCABULARY of the Chippeway Indians in J. Long's Voyages and Travels (1791) conveys a slight knowledge of the fur trader's vernacular of just a century ago. The records offer many attractions to the naturalist, acquainting him with the curious Indian names for animals, together with their English equivalents, and exhibiting the original forms of many words familiar now only in a modified or corrupted state. In this vocabulary the Indian word *quickwahay* is translated "beaver eater," and neither of the terms being current to-day in natural history, they suggest a field for investigation.

To discover the truths which are the foundation of most fables is a task both useful and interesting, and the curious facts which underlie the fabulous history of the animal about to receive our consideration illustrate this rule in an extreme degree. If a bad name be sufficient excuse for hanging a dog, what should be the fate of that animal whose evil names outnumber his digits? Probably no animal has ever possessed a longer list of synonyms, and none could possibly possess worse. The first written accounts of our subject date back to Olaus Magnus

(1562). He attributed to it most disgusting habits and applied the supposed appropriate name of *gulo*—a "glutton." Judging the animal by its external appearances, it was classed with the *Ursidæ*, or bear family; and its gluttony made it at once conspicuous in comparison with its less voracious relatives. That the "glutton" is grossly carnivorous is a fact, but the stories of its insatiable appetite, and its reputed habits of gorging till distended like a balloon, and the consequent method of obtaining relief, are purely fabulous.

With the discovery of America a magnificent field was opened to adventurers, and "travelers' tales" found extraordinary inspiration. In 1663 Pierre Bouchet, the Governor of Three Rivers, in New France, described an animal "smaller than a fox, that climbs up trees; it is called 'child of the devil,'" and rapidly following this account came the most astounding stories. Not so repulsive but quite as improbable accomplishments were freely

The shaded portion shows the distribution of the beaver eater, while the lines — — — mark the northern and southern limits of the beaver.

recounted. The animal, it was said, killed the moose and caribou, and was more than a match for bear or wolf; but as for the timid beaver, the appellation "beaver eater" significantly suggests the fate of this defenseless rodent. It is important to remember that during almost the entire period in which these fables were so current the object of the chase was beaver pelts. Giant monopolies

controlled the traffic and inspired relentless war upon the innocent owners of these integuments. In olden times the hapless beaver was hunted for his castoreum pouches, which, Pliny says, the creature would bite off and leave to the hunter as a ransom for its life; but no compromise was possible when its coat was demanded in midwinter. Thus every beaver was the counterpart or token of value for some article of use or ornament,

A Simple Form of the "Deadfall."

brought from France to quicken the cunning and perseverance of the trapper, who would naturally exaggerate his losses, although the slaughter of beavers each fall and spring by the ever-watchful "beaver eater" must have been very appreciable. It is also worth noting that the distribution of the destroyer completely overlaid that of the destroyed, and that where the beaver has been exterminated the "beaver eater" has soon disappeared. The explanation of the other romances lies in the fact that the gourmand having already well earned unenviable notoriety, had the sins of the cougar, the lynx, the badger, and the fisher visited upon him, and many feats impossible otherwise to understand are thus accounted for.

The Indians called it *ommeethatsees* and *okeecoohawgew*, as well as *quickwahay;* and corruptions from these have given us the English forms *queequehatch, quiquihatch, quiquehatch, quickehatch*, and *quickhatch;* also the French *quincajou, corvajou, corcajue, cartajou, carcayou, karkajou*, and *carcajou*, to one or other of which forms we find references in nearly all early American writings. The trials endured by the luckless hunter, whose track was once discovered by this monster, are frequently recounted. Day after day would the hunter visit his traps, only to find the ruinous work of his four-footed enemy, who, not satisfied with robbing the occasional prize, would often, simply for the morsel of bait, completely destroy scores of traps. Hence arose the

stories of the impossibility of trapping the fiend. No deadfall, snare, or spring gun ever injured this "evil one," and it does not require a vivid imagination to trace the growth of fiction, when we consider the impulsive *coureur de bois*, after the toil of setting his chain of traps and visiting them with the result above referred to, allowing himself to believe that he was verily beset by a devil, and at the camp fire, or, better still, as the honored guest of some credulous settler, unfolding and enlarging upon his experiences. These stories, however, become comprehensible when we remember that the track through the deep snow, beaten by the snowshoes of the hunter on his rounds, formed an inviting highway along which the short-limbed quadruped could freely travel, while it soon learned that a journey of a few miles meant the picking up of a substantial meal which some kind friend had carefully placed in sheltered nooks as if regardful of its wants; for the traps of those days were mostly modifications of the "deadfall," and required but limited strength and cunning to circumvent.

The creature has always been comparatively scarce, although its habitat is large; hence the stories are widespread and the scientific study of its reputed habits difficult. That the pelt is rather an uncommon article of commerce does not necessarily imply that it is of great value, although we find numerous exaggerations associated with this feature. It is stated in reports from the East that the skin was formerly held in such high repute that the angels permitted this fur alone to appear on their celestial robes, and Eastern merchants are said to have allowed an equivalent of forty or fifty dollars per skin; yet we find no market during the past one hundred and fifty years has ever quoted the pelt at more than one fourth of these figures, and to-day's quotations place five dollars as the maximum value. The demand, being as limited as the supply, accounts for this, for the skins are not more plentiful than those of the silver fox, which easily fetch one hundred dollars. The fabulous values seem to have reference to albino varieties, which must ever have been excessively rare; and though there is much beauty in the normal coloring of rich sable brown, with the paler bands along the flanks, the utility of the pelt is restricted, owing chiefly to the coarseness of the hair; and the size—only one fourth that of the black bear skin—is of a decided mediocrity, filling but few wants.

Admitting that sufficient knowledge of the animal has now been acquired to place it in its true systematic order, it is found to have no connection whatever with the bears, nor does there appear to be any affinity with the evil spirits; while the Anglo-Saxon name, implying associations with the wolf, is equally in-

correct, and this chimerical "child of the devil" becomes a respectable member of the weasel family and its largest terrestrial representative, known now to scientists as *Gulo luscus*, and popularly as the "wolverene" or "glutton."

If the wolverene does not hibernate, but spends his winter searching the woods for mere sustenance, the musteline propensity for blood is, no doubt, the impulse which makes it the great destroyer. Who has caught the weasel sleeping? Trappers say the martens run all day as well as all night; and these traits are

THE QUICKHATCH, OR WOLVERENE.

quite pronounced in the glutton, while, also, the well-known strength, pluck, and endurance of the weasels belong naturally to it.

The early name of "beaver eater" would therefore appear to be much more appropriate than either of the terms now generally used, for it has been shown that "glutton" is quite a misnomer, and the other synonym, equally incorrect, has the additional disadvantage of uncertain orthography—each of the following forms being countenanced by good authority: wolferin, wolferine, wolferene, wolvering, wolverin, wolverine, wolveren, wolverene, wolverenne, and woolverene.

ON NEW ENGLAND AND THE UPPER MISSISSIPPI BASIN IN THE GLACIAL PERIOD.*

By Prof. JAMES D. DANA.

SINCE the publication, in this Journal, of Prof. G. F. Wright's paper on the Unity of the Glacial Epoch, nearly a year since,† this subject has been much discussed in the scientific journals of the country, and with some interesting developments besides those within the purpose of the writers.

1. It has been shown that there are good working geologists on each side of the question.

2. It has been made manifest that the advocates of unity are mainly the geologists that have investigated Eastern glacial regions in the country, and especially New England, while the advocates of two Glacial epochs are chiefly those whose glacial studies have been in more western regions.

The writer, who has thus far taken no part in the recent discussion, here states that he has found in his geological explorations, which have been extensive over New England, the State of Maine excepted, no facts that require for their explanation an appeal to two Glacial epochs, and none that has even suggested the idea.

3. The presentation of arguments on the side of unity has been moderate in tone and free from dogmatism. Among geologists on the other side, great confidence in the obvious facts has given occasion to expressions almost of accomplished triumph for the two-epoch theory.

4. Among the prominent glacial investigators, one has been on both sides of the question. Having studied glacial phenomena long and faithfully in New England, Warren Upham explained the facts which he had observed on the theory of one advancing and retreating glacier, and found evidence of its terminal moraine and another halt moraine in the islands south of New England and on part of the adjoining mainland. But after some years of study in Minnesota and the neighboring States and over the region northward through Manitoba, he adopted the theory of two Glacial epochs. Returning again to New England and revising the facts there presented, he was led back to his former opinion, as he has announced in his recent papers. Since no geologist in America is better acquainted with the facts on the two sides, or more faithful and earnest in glacial investigation, these changes in his conclusions have special interest.

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* From the American Journal of Science, vol. xlvi, November, 1893.

† Vol. xliv, p. 351.

5. As the above review of facts makes manifest, the division among geologists on the question, and the differences in intensity of opinion, are to a large extent geographical.

The cause of this sectional divergence in views deserves consideration. The writer has come to the conclusion that the cause is largely *meteorological:* that the geological differences in opinion are a consequence not only of differences in observed facts in the West as compared with those of the East, but back of these, in meteorological differences in the two regions during the Glacial period.

At the present time the glaciated areas of eastern and central North America differ widely in hygrometric conditions. For New England and three fourths of the State of New York the mean annual precipitation, according to Schott's maps, varies from thirty-eight to forty-two inches—a broad coast region, nearly half the breadth of New England, excepted over which it amounts in some parts to fifty inches; while for Wisconsin it varies from thirty-two to thirty-eight inches, and for the larger part of Minnesota, from twenty to thirty-two inches. North of New England, in British America east of Hudson Bay, the annual precipitation is from thirty-two to twenty inches; but to the west of this region, over Manitoba and beyond, it is twenty to ten inches.

Here is a large present difference between the eastern and western regions, affecting snowfalls as well as rainfalls.

Now, in the Glacial period, this eastern region would not only have had the same great advantage as now of proximity to the Atlantic Ocean, but also that of greater height than now. The evidence appears to be conclusive that along the Atlantic side of the continent from southern New England northward, as well as on the Pacific side, the continent stood much above its present level, and that the elevation was the culmination of that which was in progress during the closing part of the Tertiary era—as urged by Prof. Upham. However much the surface of the great medial valley of the continent was raised, it can not be reasonably questioned that the border mountain regions experienced the greater amount of elevation. Hence, with the mountain condensers on the east so much increased in altitude and extent, the differences between the eastern and interior regions as to precipitation would have been greatly augmented, to the advantage of the eastern region.

Further, the Glacial period was probably a time of greater precipitation than now, as well as of greater cold. Some have said, of greater precipitation, and not of greater cold; but the former of these two statements has general acceptance. If the surface waters of the Atlantic basin were warmer than now—owing to a rise of land along a belt from southeast to northwest through

Iceland as part of the general rise on the American and European sides—this would account for greater precipitation on the borders of the ocean, and especially over its western border, the American.

But leaving this source of increased precipitation out of consideration, it is plain that in the Glacial period the difference in amount of precipitation over the high eastern border made into a lofty ice plateau by the accumulation of snow and ice, and over the broad medial belt from Wisconsin and Minnesota northwestward, should have been much greater than it is now. Moreover, this central valley of North America would have had something of the existing disadvantage of a relatively warm summer temperature. At the present time, in July, a mean temperature of 70° Fahr. extends beyond the latitude of Lake Winnipeg even to 56° north, and this is 10° in latitude, or nearly seven hundred miles, farther north than the position of the same heat line over New England.

The advantages for ice-making of eastern over central North America were, therefore, very great, both as regards temperature and precipitation. When the conditions over the interior were sufficient to produce a small annual gain of ice, those over New England would have been making a very large annual gain. A small gain continued for many scores of centuries would make finally a great thickness of ice. But with the conditions over the interior near the critical point, a small unfavorable meteorological change, if long continued, might carry off the ice for scores or hundreds of miles from a southern limit, with proportionate floods from the melting, while the eastern border was all the time gaining in ice, or was making only a short retreat.

The actual facts correspond with these views. The distance in the upper Mississippi basin between the farthest southern limit of the ice and the line of the great moraine, or that of the so-called "second Glacial epoch," is over five hundred miles; but to the eastward it narrows through Indiana, Ohio, Pennsylvania, and New Jersey; and in New England a corresponding moraine interval can not be certainly made out, and nothing exists that could not be better explained by reference to short retreats in a single glacier.

I leave the subjects here for the consideration of geologists of the East and West. The cause appealed to explains at least why the geologists of the East and West are divided on the subject; and also why the grand display of terminal and retreat moraines characterizing the West produces there the stronger opinions and the stronger expressions of opinions; and why also a complete survey of the facts will probably lead to a general agreement in favor of a single Glacial epoch only.

THE LATE PROFESSOR TYNDALL.*

By HERBERT SPENCER.

AMONG the various penalties entailed by ill-health, a not infrequent one is the inability to pay the last honors to a valued friend; and sometimes another is the undue postponement of such tribute to his memory as remains possible. Of both these evils I have just had experience.

It was, I think, in 1852 that Prof. Tyndall gave at the Royal Institution the lecture by which he won his spurs: proving, as he then did, to Faraday himself, that he had been wrong in denying diamagnetic polarity. I was present at that lecture; and when introduced to him very shortly after it, there commenced one of those friendships which enter into the fabric of life and leave their marks. Though both had pronounced opinions about most things, and though neither had much reticence, the forty years which have elapsed since we first met witnessed no interruption of our cordial relations. Indeed, during recent years of invalid life suffered by both of us, the warmth of nature characteristic of him has had increased opportunity for manifesting itself. A letter from him, dated November 25th, inquiring my impressions concerning the climate of this place (St. Leonards), raised the hope that something more than intercourse by correspondence would follow; but before I received a response to my reply there came the news of the sad catastrophe.

I need not dwell on the more conspicuous of Prof. Tyndall's intellectual traits, for these are familiar to multitudes of readers. His copiousness of illustration, his closeness of reasoning, and his lucidity of statement, have been sufficiently emphasized by others. Here I will remark only on certain powers of thought, not quite so obvious, which have had much to do with his successes. Of these the chief is "the scientific use of the imagination." He has himself insisted upon the need for this, and his own career exemplifies it. There prevail, almost universally, very erroneous ideas concerning the nature of imagination. Superstitious peoples, whose folklore is full of tales of fairies and the like, are said to be imaginative; while nobody ascribes imagination to the inventor of a new machine. Were this conception of imagination the true one, it would imply that, whereas children and savages are largely endowed with it, and whereas it is displayed in a high degree by poets of the first order, it is deficient in those having intermediate types of mind. But, as rightly conceived, imagination is the power of mental representation, and is measured by

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the vividness and truth of this representation. So conceived, it is seen to distinguish not poets only, but men of science; for in them, too, "imagination bodies forth the forms [and actions] of things unknown." It does this in an equal, and sometimes even in a higher degree; for, strange as the assertion will seem to most, it is nevertheless true that the mathematician who discloses to us some previously unknown order of space-relations, does so by a greater effort of imagination than is implied by any poetic creation. The difference lies in the fact that, whereas the imagination of the poet is exercised upon objects of human interest and his ideas glow with emotion, the imagination of the mathematician is exercised upon things utterly remote from human interest, and which excite no emotion: the contrasted appreciations of their respective powers being due to the circumstance that whereas people at large can follow, to a greater or less extent, the imaginations of the poet, the imaginations of the mathematician lie in a field inaccessible to them, and practically non-existent.

This constructive imagination (for we are not concerned with mere reminiscent imagination), here resulting in the creations of the poet and there in the discoveries of the man of science, is the highest of human faculties. With this faculty Prof. Tyndall was largely endowed. In common with successful investigators in general, he displayed it in forming true conceptions of physical processes previously misinterpreted or uninterpreted; and, again, in conceiving modes by which the actual relations of the phenomena could be demonstrated; and, again, in devising fit appliances to this end. But to a much greater extent than usual, he displayed constructive imagination in other fields. He was an excellent expositor; and good exposition implies much constructive imagination. A pre-requisite is the forming of true ideas of the mental states of those who are to be taught; and a further pre-requisite is the imagining of methods by which, beginning with conceptions they possess, there may be built up in their minds the conceptions they do not possess. Of constructive imagination as displayed in this sphere, men at large appear to be almost devoid; as witness the absurd systems of teaching which in past times, and in large measure at present, have stupefied, and still stupefy, children by presenting abstract ideas before they have any concrete ideas from which they can be drawn. Whether as lecturer or writer, Prof. Tyndall carefully avoided this vicious practice.

In one further way was his constructive imagination exemplified. When at Queenwood College he not only took care to set forth truths in such ways and in such order that the comprehension of them developed naturally in the minds of those he taught —he did more: he practiced those minds themselves in construct-

ive imagination. He so presented his problems as to exercise their powers of investigation. He did not, like most teachers, make his pupils mere passive recipients, but made them active explorers.

As these facts imply, Prof. Tyndall's thoughts were not limited to physics and allied sciences, but passed into psychology; and though this was not one of his topics, it was a subject of interest to him. Led as he was to make excursions into the science of mind, he was led also into that indeterminate region through which this science passes into the science of being; if we can call that a science of which the issue is nescience. He was much more conscious than physicists usually are that every physical inquiry, pursued to the end, brings us down to metaphysics, and leaves us face to face with an insoluble problem. Sundry propositions which physicists include as lying within their domain do not belong to physics at all, but are concerned with our cognitions of matter and force: a fact clearly shown by the controversy at present going on about the fundamentals of dynamics. But in him the consciousness that there here exists a door which, though open, science can not pass through, if not always present, was ever ready to emerge. Not improbably his early familiarity with theological questions given him by the controversy between Catholicism and Protestantism, which occupied his mind much during youth, may have had to do with this. But whatever its cause, the fact, as proved by various spoken and written words, was a belief that the known is surrounded by an unknown, which he recognized as something more than a negation. Men of science may be divided into two classes, of which the one, well exemplified in Faraday, keeping their science and their religion absolutely separate, are untroubled by any incongruities between them; and the other of which, occupying themselves exclusively with the facts of science, never ask what implications they have. Be it trilobite or be it double-star, their thought about it is much like the thought of Peter Bell about the primrose. Tyndall did not belong to either class; and of the last I have heard him speak with implied scorn.

Being thus not simply a specialist but in considerable measure a generalist, willingly giving some attention to the organic sciences, if not largely acquainted with them, and awake to "the humanities," if not in the collegiate sense, yet in a wider sense—Tyndall was an interesting companion; beneficially interesting to those with brains in a normal state, but to me injuriously interesting, as being too exciting. Twice I had experience of this. When, after an injury received while bathing in a Swiss mountain-stream, he was laid up for some time, and, on getting back to England, remained at Folkestone, I went down to spend a few days

with him. "Do you believe in matter?" was a question which he propounded just as we were about to bid one another good-night after a day's continuous talking. Ever since a nervous breakdown in 1855, over my second book, talking has told upon me just as much as working, and has had to be kept within narrow limits; so that persistence in this kind of thing was out of the question, and I had to abridge my stay. Once more the like happened when, after the meeting of the British Association at Liverpool, we adjourned to the Lakes. Gossip, which may be carried on without much intellectual tax, formed but a small element in our conversation. There was almost unceasing discussion as we rambled along the shore of Windermere, or walked up to Rydal Mount (leaving our names in the visitors' book), or as we were being rowed along Grasmere, or when climbing Loughrigg on our way back. Tyndall's intellectual vivacity gave me no rest, and after two utterly sleepless nights I had to fly.

I do not think that on these occasions, or on any other occasion, politics formed one of our topics. Whether this abstention resulted by accident or whether from perception that we should disagree, I can not say—possibly the last. Our respective leanings may be in part inferred from our respective attitudes toward Carlyle. To me, profoundly averse to autocracy, Carlyle's political doctrines had ever been repugnant. Much as I did, and still do, admire his marvelous style and the vigor, if not the truth, of his thought—so much so that I always enjoy any writing of his, however much I disagree with it—intercourse with him soon proved impracticable. Twice or thrice, in 1851–'52, I was taken to see him by Mr. G. H. Lewes; but I soon found that the alternatives were—listening in silence to his dogmas, sometimes absurd, or getting into a hot argument with him, which ended in our glaring at one another; and as I did not like either alternative I ceased to go. With Tyndall, however, the case seems to have been different—possibly because of greater tolerance of his political creed and his advocacy of personal government. The rule of the strong hand was not, I fancy, as repellent to Tyndall as to me; and, indeed, I suspect that, had occasion offered, he would not have been reluctant to exercise such rule himself. Though his sympathies were such as made him anxious for others' welfare, they did not take the direction of anxiety for others' freedom as the means to their welfare; and hence he was, I suppose, not in pronounced antagonism with Carlyle on these matters. But divergent as our beliefs and sentiments were in earlier days, there has been in recent days mutual approximation. A conversation with him, some years since, made it manifest that personal experience had greatly shaken the faith he previously had in public administrations, and made him look with more favor on the view of State-

functions held by me. On the other hand, my faith in free institutions, originally strong (though always joined with the belief that the maintenance and success of them is a question of popular character), has in these later years been greatly decreased by the conviction that the fit character is not possessed by any people, nor is likely to be possessed for ages to come. A nation of which the legislators vote as they are bid, and of which the workers surrender their rights of selling their labor as they please, has neither the ideas nor the sentiments needed for the maintenance of liberty. Lacking them, we are on the way back to the rule of the strong hand in the shape of the bureaucratic despotism of a socialist organization, and then of the military despotism which must follow it; if, indeed, some social crash does not bring this last upon us more quickly. Had we recently compared notes, I fancy that Tyndall and I should have found ourselves differing but little in our views concerning the proximate social state, if not of the ultimate social state.

In the sketch he has recently given of our late friend, who was one of the small group known as the *x* Club, Prof. Huxley has given some account of that body. Further particulars may not unfitly be added; one of which may come better from me than from him. The impression that the club exercised influence in the scientific world (not wholly without basis, I think) was naturally produced by such knowledge as there eventually arose of its composition. For it contained four presidents of the British Association, three presidents of the Royal Society, and among its members who had not filled these highest posts there were presidents of the College of Surgeons, of the Mathematical Society, and of the Chemical Society. Out of the nine I was the only one who was fellow of no society, and had presided over nothing. I speak in the past tense, for, unhappily, the number of members is reduced to five, who are now scattered, and of these only three are in good health. For years past the difficulties in the way of meeting have been growing greater, and the club is practically dead. But the detail of most interest which Prof. Huxley has not given, concerns a certain supplementary meeting which, for many years, took place after the close of our session. This lasted from October in each year to June in the next, and toward the close of June we had a gathering in the country to which the married members brought their wives; raising the number on some occasions to fifteen. Our programme was to leave town early on Saturday afternoon, in time for a ramble or a boating excursion before dinner; to have on the Sunday a picnic in some picturesque place adjacent to our temporary quarters; and, after dinner that evening, for some to return to town, while those with less pressing engagements remained until the Monday morning. Two of our

picnics were held under Burnham Beeches, one or more on St. George's Hill, Weybridge, and another in Windsor Forest. As our spirits in those days had not been subdued by years, and as we had the added pleasure of ladies' society, these gatherings were extremely enjoyable. If Tyndall did not add to the life of our party by his wit he did by his hilarity. But my special motive for naming these rural meetings of the x is that I may mention a fact which, to not a few, will be surprising and perhaps instructive. We sometimes carried with us to our picnic a volume of verse, which was duly utilized after the repast. On one occasion, while we reclined under the trees of Windsor Forest, Huxley read to us Tennyson's "Œnone," and on another occasion we listened to Tyndall's reading of Mrs. Browning's poem, "Lady Geraldine's Courtship." The vast majority of people suppose that science and poetry are antagonistic. Here is a fact which may perhaps cause some of them to revise their opinions.

From the impressions of Tyndall which these facts indirectly yield, let me return to impressions more directly yielded. Though it is scarcely needful to say anything about his sincerity, yet it can not properly be passed over, since it was a leading trait in his nature. It has been conspicuous to all, alike in his acts and his words. The Belfast address to the British Association exhibited his entire thought on questions which most men of science pass over from prudential considerations. But in him there was no spirit of compromise. It never occurred to him to ask what it was politic to say, but simply to ask what was true. The like has of late years been shown in his utterances concerning political matters—shown, it may be, with too great an outspokenness. This outspokenness was displayed, also, in private, and sometimes perhaps too much displayed; but every one must have the defects of his qualities, and where absolute sincerity exists, it is certain now and then to cause an expression of a feeling or opinion not adequately restrained. But the contrast in genuineness between him and the average citizen was very conspicuous. In a community of Tyndalls (to make a wild supposition) there would be none of that flabbiness characterizing current thought and action—no throwing overboard of principles elaborated by painful experience in the past, and adoption of a hand-to-mouth policy unguided by any principle. He was not the kind of man who would have voted for a bill or a clause which he secretly believed would be injurious, out of what is euphemistically called "party loyalty," or would have endeavored to bribe each section of the electorate by *ad captandum* measures, or would have hesitated to protect life and property for fear of losing votes. What he saw right to do he would have done, regardless of proximate consequences.

The ordinary tests of generosity are very defective. As rightly

measured, generosity is great in proportion to the amount of self-denial entailed; and where ample means are possessed large gifts often entail no self-denial. Far more self-denial may be involved in the performance, on another's behalf, of some act which requires time and labor. In addition to generosity under its ordinary form, which Prof. Tyndall displayed in unusual degree, he displayed it under a less common form. He was ready to take much trouble to help friends. I have had personal experience of this. Though he had always in hand some investigation of great interest to him, and though, as I have heard him say, when he had bent his mind to a subject he could not with any facility break off and resume it again, yet, when I have sought his scientific aid—information or critical opinion—I never found the slightest reluctance to give me his undivided attention. Much more markedly, however, was this kind of generosity shown in another direction. Many men, while they are eager for appreciation, manifest little or no appreciation of others, and still less go out of their way to express it. With Tyndall it was not thus: he was eager to recognize achievement. Notably in the case of Faraday, and less notably, though still conspicuously, in many cases, he has bestowed much labor and sacrificed many weeks in setting forth others' merits. It was evidently a pleasure to him to dilate on the claims of fellow-workers.

But there was a derivative form of this generosity calling for still greater eulogy. He was not content with expressing appreciation of those whose merits were recognized, but he spent energy unsparingly in drawing public attention to those whose merits were unrecognized; and time after time, in championing the causes of such, he was regardless of the antagonisms he aroused and the evils he brought on himself. This chivalrous defense of the neglected and the ill-used has been, I think, by few, if any, so often repeated. I have myself more than once benefited by his determination, quite spontaneously shown, that justice should be done in the apportionment of credit; and I have with admiration watched like actions of his in other cases—cases in which no consideration of nationality or of creed interfered in the least with his insistance on equitable distribution of honors.

In thus undertaking to fight for those who were unfairly dealt with, he displayed in another direction that very conspicuous trait which, as displayed in his Alpine feats, has made him to many persons chiefly known—I mean courage, passing very often into daring. And here let me, in closing this sketch, indicate certain mischiefs which this trait brought upon him. Courage grows by success. The demonstrated ability to deal with dangers produces readiness to meet more dangers, and is self-justifying where the muscular power and the nerve habitually prove adequate. But the

resulting habit of mind is apt to influence conduct in other spheres, where muscular power and nerve are of no avail—is apt to cause the daring of dangers which are not to be met by strength of limb or by skill. Nature, as externally presented in precipices, ice-slopes, and crevasses, may be dared by one adequately endowed; but Nature, as internally presented in the form of physical constitution, may not be thus dared with impunity. Prompted by high motives, Tyndall tended too much to disregard the protests of his body. Over-application in Germany caused at one time absolute sleeplessness for, I think he told me, more than a week; and this, with kindred transgressions, brought on that insomnia by which his after-life was troubled, and by which his powers of work were diminished; for, as I have heard him say, a sound night's sleep was followed by marked exaltation of faculty. And then, in later life, came the daring which, by its results, brought his active career to a close. He conscientiously desired to fulfill an engagement to lecture at the Royal Institution, and was not to be deterred by fear of consequences. He gave the lecture, notwithstanding the protest which for days before his system had been making. The result was a serious illness, threatening, as he thought at one time, a fatal result; and, notwithstanding a year's furlough for the recovery of health, he was eventually obliged to resign his position. But for this defiance of Nature there might have been many more years of scientific exploration, pleasurable to himself and beneficial to others; and he might have escaped that invalid life which for a long time past he had to bear.

In his case, however, the penalties of invalid life had great mitigations—mitigations such as fall to the lot of but few. It is conceivable that the physical discomforts and mental weariness which ill-health brings may be almost compensated, if not even quite compensated, by the pleasurable emotions caused by unflagging attentions and sympathetic companionship. If this ever happens, it happened in his case. All who have known the household during these years of nursing are aware of the unmeasured kindness he has received without ceasing. I happen to have had special evidence of this devotion on the one side and gratitude on the other, which I do not think I am called upon to keep to myself, but rather to do the contrary. In a letter I received from him some half-dozen years ago, referring, among other things, to Mrs. Tyndall's self-sacrificing care of him, he wrote: "She has raised my ideal of the possibilities of human nature."

THE ORIGIN OF ART.

By M. LAZAR POPOFF.

WE are accustomed to say that Egypt is the cradle of the arts; yet archæologists have demonstrated that the earliest works of art are of epochs far anterior to the ancient Egyptian civilizations. According to these authors, these works were contemporaneous with the presence of the reindeer in the south of France, and of a time when the mammoth had not yet disappeared, and when man, ignorant of the metals, made all his instruments of stone, wood, and bone. In reality, the first works of art, particularly the first efforts at drawing, date from prehistoric times. In France they are found in caverns by the side of the fossil remains of animals now extinct, like the mammoth, or which have abandoned those regions, like the reindeer, in the shape of drawings engraved with flint points as decorations of articles of reindeer horn, such as dagger handles and clubs. Drawings have also been observed on tablets of stone, horn, or ivory derived from mammoth's teeth.

We do not intend to dwell on the rudimentary, merely outline drawings, of which these ornaments consist. We invite special attention to more perfect and more characteristic works, in which, as Carl Vogt remarks, the spirit of observation and imitation of Nature, especially of living Nature, is remarkably manifest. The figure of the mammoth attracts our notice at once. A drawing found in the cavern of *La Magdelaine*, in the Dordogne, engraved on a tablet of mammoth bone, is marked by the strikingly clumsy attitude of the unwieldy body of the animal, by its long hair, the form of its lofty skull with concave front, and its enormous recurved tusks. All these features, characteristic of this extinct type of pachyderm, have been reproduced by the designer with a really artistic accuracy. The mammoth was already rare in Europe when this primitive artist lived; and that, perhaps, is the reason why only two among the numerous drawings found in the caverns of France are of that animal.* The second of these drawings, which was found in *La Lozère*, is a mammoth's head sculptured on a club.

The figures of the chamois, the bear, and the ox occur more frequently; but those of the reindeer are most numerous. Some are engraved on plates of bone, others as ornaments of various articles. Sometimes groups of animals are represented; or, on the other hand, only parts of them are given, and we see simply the head, or the head and bust.

* Similar decorations in outline have been found in Belgian caverns, and are referred by Dupont to the age of the mammoth.

The large majority of these drawings are no better executed than those which school children make on walls. The figures of the reindeer, however, are superior, by the remarkable care with which the characteristic lines of the animal are traced, and also, in rare specimens, by the addition of shadows. The drawings of the chamois, the bear, and the ox are likewise often strikingly exact and of real value.

Besides these drawings of mammals, several representations of fishes, exact but very uniform, have been found in caverns in France. As a whole, as Broca remarks, all these relics of primitive art demonstrate that the men of this prehistoric period carefully observed the forms and attitudes of animals, and were capable of representing them exactly and elegantly, attesting a real artistic sense.

No such skill has been observed with reference to the representation of the human figure; and designs in which it appears are extremely rare. Of two of them, one represents a man naked, armed with a club, and surrounded by animals; and the second, a fishing scene, in which a man is lancing a harpoon at some marine animal—a fish, according to Broca; a whale, according to others. In this piece we are most interested in the man. The drawing, as a whole, is puerile and deformed, and the proportions are surprisingly violated. The specimen is not an exception, for the examination of all the drawings of this kind proves that the men of those times, while very skillful in the representation of animals, especially of those which were important to them, were very poor delineators of the human figure.

Another not less characteristic point is the complete absence of drawings of plants. No representation of a tree, or bush, or even of a flower is found, unless we regard as of that character the three little rosettes engraved on a handle of reindeer horn, which some authors think is the figure of a composite flower. Such undoubted exclusiveness on the part of the inhabitants of the caves was evidently not accidental, for chance explains nothing; and we can not admit, with Carl Vogt, that primitive drawing originated in a general tendency of man to the imitation of living Nature. We think the object of these artistic productions was of a quite different character, and that they were originally designed, not for ornament or for pure and simple imitation of Nature, but to secure an instrument for use in the struggle with Nature.

We remark, first, that there is nothing to prove that the men of that epoch were mentally superior to modern savages; and, if we observe these, we shall ascertain that their drawings have usually a very different significance from what they have among civilized peoples, and nothing in common with decoration and æsthetics in general. Numerous facts prove that human thought

in the lower stages of its development distinguishes poorly between subjective representations and objective results, and that both give rise to the same ideas. For instance, a savage seeing one of his family in a dream can not imagine that the image is independent of the organic substance of the personage in question; and he will see the same relation between the two as between a body and its image reflected from the surface of the water. Thus the Basutos think that if the shadow of a man is projected upon the water the crocodiles will obtain possession of the man. A similar identification may be pushed to the point that some tribes are known which use the same word to designate the soul, the image, and the shadow. This is the essential fact to be taken into consideration in order to regard primitive design in its real meaning, and to restore the conditions of the medium in which it originated. If we suppose such a material relation between the image and the object as there is between the shadow and the object, it becomes evident that the savage should deport himself in the same way toward the image, the shadow, and the object. From his point of view the image and the object it represents are in close relation, and in acting upon the one he would be acting in the same way upon the other. By virtue of this way of thinking the savage is convinced that harm done to the image passes to the object, or that in acting upon the copy we attack the original.

Proofs are numerous to demonstrate the importance which savages attribute to this mode of action on the original. Waitz tells, following Denghame, that it was dangerous in a certain tribe of West Africa to paint the portraits of natives, because they were afraid that a part of their soul would pass, by some necromancy, into the image. Sir John Lubbock notices the fear of their portrait entertained by savages—and the more like the portrait, the greater the danger to the original was supposed to be. Dr. Kane got rid of the Indians one day when they were making themselves troublesome to him by beginning to paint their portraits. Catlin relates an incident, at the same time sad and comic, of his drawing the profile of a chief named Matochiga, when the Indians around him seemed all at once very much moved. "Why did you not draw the other half of his face?" they asked; "Matochiga was never ashamed to look a white man in the face." Matochiga did not appear to have taken offense till then, when one of the Indians came up to him and, laughing, said, "The Englishman knows very well that you are only half a man, and he has only drawn half of your face because the other is worth nothing." A fatal quarrel followed this expression, and Matochiga was killed by a bullet which struck him on the side of the face that had not been drawn.

Charlevoix says that the Illinois and other Indian tribes made

little figures representing persons whose lives they wished to curtail, and stabbed them in the place of the heart. A custom still exists in Borneo of making a figure in wax of an enemy whom one desires to bewitch and melting it before the fire. They say that the person designated will waste away as his image disappears. Peruvian sorcerers proceed in the same way, except that their figures are made of rags. In the East Indies, according to Dubois, they knead with hair or bits of skin, earth collected in some muddy place, of which they make a figure, on the breast of which they write the name of an enemy; then stab the figure with needles, or otherwise mutilate it—always in the belief that similar injuries will be inflicted upon the person represented.

Vestiges of this primitive superstition are furthermore found among civilized peoples; for, as Grimm relates, Jews were accused, in the eleventh century, in Europe, of having slain Bishop Ebergard by the aid of witchcraft of this kind. These Jews had each a figure of wax representing the bishop, had bribed a priest to baptize it, and had then thrown it in the fire. The wax had hardly melted when the bishop was struck with mortal illness.

The famous adventurer Jacob, chief of the Pastoureaux, who lived in the thirteenth century, believed seriously, as he says in his Demonology, that the devil taught men the art of making images of wax and clay, the destruction of which involved the death of the persons whom they represented. In the time of Catherine de Medicis it was a custom to make such figurines of wax and to melt them over a slow fire, or stab them with needles, in order to make their enemies suffer. The operation was called *envoûtement* (or spell-binding).

We shall not be done unless we cite all the facts that prove that in the mind of the primitive man it is enough to possess any object—a piece of a coat, hair, a bit of a nail—that has belonged to a person to have power to act on him and do him harm. Faith in the efficiency of this means is so strong among backward peoples that persons who have any reason to suspect others hide their clothes in order that no part of them may be stolen. Others, when they cut their hair or nails, put the cut parts on the roof of their house or bury them. So peasants in some countries do with extracted teeth. We add, to complete our picture, that writing is regarded by the savage as endowed with the same magic force as drawing—a fact we may easily comprehend if we recollect that picture-writing preceded writing with letters or any conventional signs, and is still practiced among some savage tribes. In these picture-writings the subjection of a man or an animal to bad luck is indicated by an arrow drawn from the mouth to the heart. A sign of that kind is supposed to be equivalent to a real taking possession of the animal or the person represented.

It is doubtful whether we could give more evident proofs of the entirely special significance attributed by the savage to drawing, regarded by him as an instrument of power over another. While the examples we have cited relate particularly to man, it is logical to assume that the same process—that is, the figurative representation of animals—plays a like part in the struggle of the savage against his natural enemies. There exist other facts that confirm this hypothesis.

According to Mr. Tanner, the North American Indians, to assure success in their hunts, made rude drawings of the animals they pursue, with arrows sticking through the place of the heart, believing that they will by this means obtain power to cause the game they seek to fall into their hands. The Australians, according to an observer quoted by Tylor, make a figure of the kangaroo of grass in order to become the masters of the real kangaroos in the bush. When an Algonkin Indian wanted to slay an animal, he made a grass figure of it and hung it up in his lodge. Then, having named it several times, he shot an arrow at the image. If he hit it, it was a sign that he would kill the animal on the morrow.

In the same way, if the hunter, after he had touched the wand of a wizard with his arrow, strikes the track of an animal with the same arrow, the animal will be stopped in its flight and held till the hunter can catch up with it. The same result, according to the aborigines, can be easily secured by drawing the figure of the animal on a piece of wood, and praying to the image for success in the hunt.

Here, then, we have, in substance, the origin of the part played by drawing. An Indian song expresses this part admirably in the words, "My picture makes a god of me," and it is really doubtful whether faith in the powerful significance of the art of drawing as an instrument by the aid of which primitive man could obtain a supernatural power over his enemy or his game could be more powerfully expressed.

If we now consider the works of the cave men in the light of these facts, we shall recognize that the object that inspired them had really few points in common with the sense of beauty or the tendency to imitation; and it is clear that if there existed in the mind of primitive man a material relation between a being and its shadow or its image, that man would believe that the same relation was preserved between that being and its image transferred to any object. The purpose sought was to possess one's self of the shadow of the desired object, and the only way of doing that was to fix the silhouette of the shadow on some article. This, in our opinion, was the primary purpose of drawing, and consequently of painting.

It is noteworthy that all works of this kind appertaining to the embryonal period of the arts of design display the want of proportionality, the absence of symmetry characteristic of silhouettes of shadows. The uniform impression given by these drawings is that they refer, not to the objects themselves, but to their shadows. It is likewise interesting to remark that some contemporaneous savages—some Australians, for example—are still incapable of grasping the meaning of the most perfectly faithful images, while they readily understand a rude, ill-proportioned drawing. Thus, to give them the idea of a man, he must be drawn with a greatly enlarged head—a detail, the spirit of which is paralleled upon a drawing found in a cavern in France, and representing a fisherman. He has a very small body, but his hand, armed with an enormous harpoon, is the hand of a giant.

In his struggle with surrounding Nature—a struggle of which it is almost impossible for us to conceive an exact idea—the first need of primitive man was to possess some means of giving him confidence in victory. In going to the hunt he took with him, as the North American Indian does, and as do under another form some of the gamblers in our most civilized circles, the fetich that was to assure his success—that is, the image of the animal he wanted to kill. In engraving on the handle of his dagger the likeness of a reindeer or other animal, he was not thinking of decorating his weapon, but only of bringing some magic power to bear upon his prey; and it was precisely faith in that mysterious force, by giving him boldness, energy, and security of movement, that would procure him success. Confidence acts thus in everything.

Like the modern savage, the man of the caves believed that the greater the resemblance between the animal and its likeness, the greater was the chance of acting on the animal. Hence the care taken in the pictured reproduction of animals particularly sought for, and against which his struggle was the most earnest; hence those perfect drawings of the reindeer, that magnificent game of our ancestors. Very different are the characteristics of the drawings of human forms. To account for these differences, it must be considered that all the archæological data relative to the epoch of the reindeer are unanimous in attesting that the man of that age was of a peaceful character.

While, then, we are justified in believing that the men of the caverns very rarely raised their hands against one another, it is none the less certain that they led a bitter and truceless struggle against animals. They therefore rarely had occasion to practice the drawing of the human figure; whence the great imperfections of the figures of that kind as compared with the figures of animals.

It may be remarked, with reference to plant forms, that the boreal flora of that epoch, not being at all menacing, could furnish little food for superstition, and no drawings of plants are found in the caves.

On the whole, the condition of the art of design with primitive man appears to be in complete harmony with the meaning we have attributed to design itself—it being regarded as inspired by the belief in the existence of a material relation between a being and its image, and in the possibility of acting on the object by means of the picture.

Consequently, the principle of painting is not to be found in a natural tendency of primitive man to the artificial imitation of living Nature, but seems to be derived from the wish to subject that Nature to its wants and to subdue it.

By progressive improvements, the art of drawing has gradually lost its primitive significance and original meaning till it has become what it is now. It does not differ, however, much from what it was originally; for, while primitive man fancied he could reach the living being in its image, it is still life that living man seeks to-day in works of art.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

SKETCH OF L. D. VON SCHWEINITZ.

DURING colonial times in America, and even down into the present century, science advanced over a much obstructed path. Not having then attained to its present power and esteem, there were but few of its votaries whose whole time and best energies it could command. The explorations by which the animals, plants, and minerals of the vast Western continent were made known to science were accomplished in large part by naturalists who either followed some other vocation as a means of livelihood, or were mainly occupied by some other career to which they felt more strongly bound. Franklin was a printer and later a statesman, being an electrician only at odd times; John Bartram was a farmer; Mitchell, Hosack, and Barton were physicians; while Muhlenberg and the subject of this article were clergymen.

LEWIS DAVID VON SCHWEINITZ was born, February 13, 1780, at Bethlehem, Pa., then a Moravian Church settlement which had been founded by his family in 1741. His father, Baron Hans Christian Alexander von Schweinitz, came from an ancient and distinguished family residing on the ancestral estate called Leubla, in the present limits of Saxony. That he was a man of stable

character may be inferred from the fact that he performed the responsible duties of a treasurer general for the Moravian Church in America. The mother of Lewis was Dorothea Elizabeth, daughter of Baron (afterward Bishop) John de Watteville, and Benigna, daughter of Lewis Nicholas, Count Zinzendorf. It was to Zinzendorf and Watteville that the renewal and resuscitation of the ancient church of the *Unitas Fratrum*, or Moravian Brethren, in the eighteenth century was mainly due. In 1722 two families of the Brethren crossed the frontier of Moravia by night and made their way to the estate of Count Zinzendorf in Saxony. Here they were joined by others, and in a few years the town of Herrnhut was built by the colonists. Zinzendorf took an interest in this settlement from the start, became a bishop in the church, and devoted his life to its service. The efforts of the Brethren were early turned toward foreign missions, and it was in furtherance of mission work that Zinzendorf and Watteville came to America and founded the first Moravian settlements in this country.

Being so closely connected with the re-founders of an ancient denomination, the parents of Lewis naturally looked forward to his becoming an able promoter of the interests of their church. He was their eldest son, of a decidedly intellectual temperament and an enthusiastic disposition, and when in early boyhood he developed the habit of addressing short speeches and little sermons to the family circle, his future seemed to be definitely marked out.

When a little more than seven years old, Lewis was placed in the academy of the Moravian community at Nazareth Hall, where he remained eleven years. Young Lewis received his first impulse toward scientific study when on a visit to this school with his grandfather, Bishop de Watteville, before he entered it as a pupil. Seeing a specimen of the *Lichen digitatus* lying on a table, the child examined it with interest, and was told its name and something about its physiology. From that moment he was wont to date his interest in the vegetable kingdom. After entering the school he received some instruction in the elements of botany. A partial flora of Nazareth and vicinity, made while he was at this institution, which remained among his manuscripts at his death, is evidence that this study took immediate hold upon the mind of the youth. During his school days his powers of language and his vein of satirical humor were occasionally manifested in poetical effusions. While still a pupil and not yet eighteen years of age he assisted in teaching some of the younger classes. Lewis had three brothers, none of whom ever turned to scientific pursuits, and two sisters.

In 1798 Hans von Schweinitz was called to Germany and took

his family with him. Lewis was removed from the Nazareth seminary and after the family reached Germany was entered as a student in the theological institution at Niesky, in what was then known as the province of Lusatia, in Silesia. Here he made the acquaintance of Prof. J. B. de Albertini, who became his fast friend and his fellow-worker in botanical investigations. After completing his course as a student he became a teacher in the academy. His leisure at Niesky was occupied in the pursuit of his favorite science, in general reading and study, and in writing for the literary journals of the time. In his Memoir of von Schweinitz, read before the Academy of Natural Sciences of Philadelphia, Walter R. Johnson says of his literary activity at this time: "Scarcely any important topic in the wide field of science escaped his notice, and especially did the constitution and management of the affairs of his social and religious fraternity call forth from his pen many able and spirited articles."

The first published botanical work of von Schweinitz appeared in 1805, when he was twenty-five years of age. From the beginning of his residence at Niesky he had given especial attention to the fungi, previously little studied. The association with Albertini had continued and the discoveries of the two friends in this field had been so many as to warrant the publication of a volume of about four hundred pages on the fungi of Lusatia embodying the results of their united efforts. It was written in Latin, as was still the custom for scientific works in Europe, and the twelve plates, containing figures of ninety-three new species, with which it was illustrated, were drawn and engraved by von Schweinitz's own hands. In this work the authors creditably refrained from the then too common practice of giving new names to the already known plants included in their descriptions. They were convinced that natural history had been grievously burdened by the accumulation and confusion of synonyms, many of which promoted no other purpose than an unworthy ambition.

Soon after this Mr. von Schweinitz began to preach, and in 1807 was called to the Moravian settlement at Gnadenberg, not far from Niesky. "Considered as literary performances," says Johnson, in the memoir already cited, "his sermons were characterized by the utmost simplicity, both in style and delivery, and were addressed more to the heart than to the head. His discourses were invariably practical, not argumentative—experimental, not speculative." It was now the time of Napoleon's continental wars, and troops were quartered at Gnadenberg. The inhabitants found the presence of the soldiery irksome, but the happy disposition and winning deportment of the young pastor had much influence in preventing collisions. The next year he was invited to Gnadau, in Saxony, where he remained four

years, performing the duties of his clerical office and teaching the boys of the community who were destined for learned professions.

In 1812 Mr. von Schweinitz, being then thirty-two years of age, was appointed general agent of the Moravian Church in the southern United States. Before starting for this country he married, at Niesky, Louiza Amelia Le Doux, who belonged to a French family residing at Stettin. The continental system of Napoleon rendering direct communication with the United States extremely hazardous, Mr. von Schweinitz and his wife were compelled to go through Denmark to Sweden and embark there. The trouble of making this roundabout journey was, as it chanced, not without its compensation. The travelers were obliged to make a stay of some length at Kiel, in Holstein, during which von Schweinitz formed an enjoyable acquaintance with several of the professors in the university there. His attainments, moreover, so impressed the authorities of this seat of learning that they conferred upon him the honorary degree of Doctor of Philosophy. When, at length, the voyage was begun the United States had declared war with England and the sea swarmed with privateers. The passage abounded with thrilling adventures and providential escapes. While still in European waters the vessel fell in with a French privateer and narrowly avoided capture by taking refuge under the guns of a Danish fort. A fierce cannonade between the Danes and the Frenchman followed, many of the balls passing over and through the ship. Later it was actually captured by a British frigate, but escaped in the darkness and fog of a stormy night. Much tempestuous weather was met with, and the climax came in a terrible storm which dismasted the vessel. Nevertheless, it finally entered port in safety, being the only one of fifteen or twenty American vessels sailing from Sweden on the same day that ever reached America.

The principal church settlement of the district to which von Schweinitz had been assigned was at Salem, N. C., and there he took up his residence. Although not a native of North Carolina, he had a strong predilection for that State, having often heard his father and grandfather speak of their visits to its early settlements. His official duties were very arduous. He was a member of the Governing Board of the Moravian Churches in North Carolina, a trustee of the Salem Female Academy, the administrator of the very large landed estates owned by the church in the State, and he frequently preached in Salem and other places. Yet he found time to continue his botanical researches, which he could now carry on in a dominion, scientifically speaking, all his own. On one of his exploring trips he discovered among the Sauraton Mountains, in Stokes County, a most beautiful waterfall, which still bears his name. Among his scientific correspondents at

this time were Dr. Reichenbach, of Dresden; Kunze, of Leipsic; Major Le Conte, United States Army; Blumenbach, of Göttingen; Elliott, of South Carolina; Schwaegrichen, of Leipsic; and Hooker, of England. The first fruit of his botanical work in the South was a synopsis of the fungi of North Carolina, written in Latin, which was given to the world in 1818 through the Society of Naturalists at Leipsic, under the editorial care of Dr. D. F. Schwaegrichen. Among the one thousand three hundred and seventy-three species described in this synopsis, there are three hundred and fifteen that were new to science. In the same year his duties required him to attend a synod of his religious brethren at Herrnhut. On his way he visited England, France, and Holland, and established correspondences which were of great value to him after he returned to America and began the formation of a regular herbarium. In 1821 von Schweinitz published at Raleigh, N. C., a pamphlet containing descriptions of seventy-six species of *Hepaticæ* (liverworts), among them being nine discovered by him. In the same year he contributed to the American Journal of Science, then in its fifth volume, a Monograph on the Genus *Viola*, in which five new species were described. This was a valuable paper, and was often cited by European botanists. In it he made the interesting statement that among the thirty species of violets then known in America there was not one exactly like any of the twenty European species.

During his residence at Salem, von Schweinitz had been offered the presidency of the University of North Carolina. The acceptance of this honorable position would have necessitated giving up his service in the Moravian Church, and so, feeling that the Brethren had the best claim upon his energies, he declined it. At the beginning of the year 1822 he removed to Pennsylvania, and took up his residence in his native village of Bethlehem. Here he undertook the charge of the Moravian girls' seminary at that place, and the secular office of general agent for the Brethren was retained. His botanical studies were not suffered to languish. "The beautiful slopes and valleys about Bethlehem and Nazareth," says Johnson, "the romantic banks of the Delaware, and the precipitous rocks of the Lehigh, all yielded up to him a tribute of their hitherto unexplored treasures. The high estimation set upon his works by men of science had procured his election as an honorary member in several societies devoted to natural history, both in Europe and America. His correspondence increased, and the formation of his herbarium advanced with great rapidity." About this time Major Long's expedition to the sources of the St. Peter's River, in the Northwest Territory, returned. It had been arranged that the plants collected on this trip by Thomas

Say should be described by Nuttall. The work was begun by this naturalist, but he was obliged to go to Europe, and was prevented from returning in season to do any more. The plants were accordingly put in the hands of von Schweinitz, who described them most acceptably.

Toward the end of 1823 the then well-known botanist communicated to the Lyceum of Natural History (now the Academy of Natural Sciences), of New York, a key or analytical table for determining the American species of *Carex*—the largest genus of the sedges. This production, though small in bulk, could result only from ample knowledge and exact discrimination. In 1824 the American Journal of Science published a short paper by him on the rarer plants of Easton, Pa. There was another synod at Herrnhut this year which it was necessary for him to attend, and, having a Monograph of the North American *Carices* about completed, he put the manuscript, together with a large collection of specimens, into the hands of Dr. Torrey, in order that the monograph might be communicated to the Lyceum of Natural History in his absence. He gave full liberty for making any additions or alterations warranted by Dr. Torrey's later discoveries. When he found, on returning, that his editor had made important additions to the number of species described, von Schweinitz, with characteristic conscientiousness, requested that the paper should be published as their joint production, saying that "the judicious and elaborate amendments he has proposed, and the mass of new and valuable matter he has added, entitle Dr. Torrey to a participation in the authorship of the work." The whole number of species described was one hundred and thirteen, of which six were new. This and the analytical table of the *Carices* were both printed in the first volume of the Annals of the Lyceum. In his absence a paper in which he described fifteen new American species of *Sphæriæ*, one of the largest genera of fungi, was communicated to the Academy of Natural Sciences of Philadelphia, and appeared in vol. v of its Journal.

Von Schweinitz was absent till near the end of 1825. After his return he resumed his labors as general agent for the Brethren; the charge of the school, however, had been given up some time before. The great work to which he now devoted his attention was a Synopsis of North American Fungi. He had intended this for publication in one of the European journals, but was induced to present it, in 1831, to the American Philosophical Society of Philadelphia. In this work three thousand and ninety-eight species, belonging to two hundred and forty-six genera, were described, of which twelve hundred and three species and seven genera had been discovered by the author. If to these discoveries we add those made by von Schweinitz in other orders of

plants, we have a total of nearly fourteen hundred new species added to botanic science by the talents and industry of a single observer. The whole number of species known at his death was estimated at sixty thousand.

Until he was about fifty years of age his health had been excellent. But the various and increasing cares of his official position finally had their effect. The sedentary work involved in writing a dissertation on the affairs of his community, which prevented for a time his usual out-of-door exercise, was the immediate cause of a severe cough and other alarming symptoms of decline. His spirits, which had been uniformly cheerful, became depressed. A journey to the West to establish a branch community of the United Brethren in Indiana was temporarily beneficial, but his system was undermined and the progress of disease could not be stayed. On February 8, 1834, came the end of what his memoirist calls "a life of various, constant, and unobtrusive usefulness."

A widow and four sons survived him. All the sons entered the Moravian ministry. The eldest, Emil Adolphus de Schweinitz, was born in Salem, N. C., in 1816. He filled various ecclesiastical offices in Pennsylvania and North Carolina, was made a bishop in 1874, and died in 1879. The second son, Robert, was born in Salem, in 1819. He has filled various charges and was for many years President of the Executive Board of the American Moravian Church. Since his retirement from the active ministry he has been general treasurer of the Church and of its Foreign Mission Department. The third son, Edmund Alexander, was born in Bethlehem in 1825, and died there in 1887. He also became a bishop, and was the author of several books on the history and polity of the *Unitas Fratrum*. In 1856 he established a weekly journal for the Moravians in America, which he edited for ten years. Bernard, the youngest son, was born at Bethlehem, in 1828, and died at the age of twenty-six years, being at the time in charge of a church on Staten Island. During the latter years of the father's life he used *de* in place of *von* in his name, and the sons have always used the new form.

Von Schweinitz was of high stature, erect carriage, and robust habit. The portrait accompanying this sketch is a copy of a miniature painted some years before his death, and consequently represents him in the prime of life. He had an unusually amiable and attractive disposition, which made him a general favorite with high and low. His conversational powers were of a high order, and contributed much to an ease of intercourse which was an important factor of his usefulness. Humor, anecdote, and repartee were always at his command, while the varied and exciting scenes through which he had passed and the prominent per-

sonages with whom he had come in contact furnished him an inexhaustible fund of interesting reminiscences. Strange to say, considering his German extraction, he was devoid of any appreciation for music. He spoke and wrote in English, German, French, and Latin, and was also acquainted with Greek.

A notable feature of his scientific work was its systematic character. Evidence of this is furnished by the synoptical tables attached to his several monographs, and by the fact that the analytical table of the *Carices* was one of his productions. The cryptogams had for him an attraction that they do not have for many. We owe most of our knowledge of this series of plants to German, Danish, and Swedish investigators. Knowledge that may not be read by him who runs but must be delved for, as is the case with that relating to the fungi and their near allies, seems to have an especial attraction for Northern minds.

Among his well-deserved honors was the naming after him of *Schweinitzia odorata* (sweet pinesap), by Stephen Elliott. This is a small plant, found from Maryland southward, and bears a spike of flesh-colored flowers which exhale the odor of violets.

A general characterization of the botanist's work can not be given better than in the following words of Walter R. Johnson:

"When we consider the extreme difficulty of the particular departments of botany to which Mr. Schweinitz devoted his chief attention, the prodigious number of facts which he has accumulated, the vast amount of minute and delicate investigation demanded by the nature of the objects of his study, the labor of preparing for the press the materials which he had brought together; when we recollect that, with the exception of Dr. Muhlenburg, of Lancaster, no American botanist had ventured far upon this wide and unexplored dominion of Nature, and when we remember that this science was his relaxation, not his profession—his occasional pursuit, not his daily duty—we are forcibly struck with the high order of his talents for the pursuit of physical science, and can not but regret that more of his time and energies could not have been devoted to this favorite ocupation."

Von Schweinitz bequeathed his collection of plants to the Academy of Natural Sciences of Philadelphia. It comprised twenty-three thousand species of phanerogams and many thousand cryptogams. A large portion of the specimens were from the most remote parts of the world, having been obtained by exchange with American and European explorers. They included the "Baldwin collection" from Florida, Brazil, and La Plata, which von Schweinitz had bought, and in which he had found three thousand species not before in his herbarium. The examination and arrangement of these plants had been one of his last scientific labors.

CORRESPONDENCE.

CLOSE OF THE GLACIAL PERIOD.

Editor Popular Science Monthly:

Geologists who are only slightly versed in astronomy are apt to make a serious mistake on this subject. The latest which has fallen under my notice is by Prestwich, in the article entitled The Position of Geology, in the February number of this periodical, page 541. He says: "The last of these astronomical periods was calculated to have commenced two hundred and fifty thousand years and to have ended eighty thousand years ago. These numbers have become stereotyped as those of the beginning and the end of the Glacial period."

A slight acquaintance with this subject ought to prevent mistakes such as the above. They are stereotyped only to those who give little or no heed to the actual dates and as little to a universal law of Nature touching the cumulative effects of constantly acting forces. These effects were clearly set forth by Prof. Le Conte some years ago in treating of this general subject. The day of the summer solstice is not the day of greatest heat or the middle of the hot season; nor is the day of the winter solstice in the middle of the cold season. The maximum in the two cases occurs about six weeks after those dates respectively, an amount about equal to one fourth of the whole time from one extreme to the other. These are elementary truths, and whoever omits them in this discussion repeats the old story of "playing Hamlet with Hamlet left out."

The following is a brief statement of the essential points in the case: Two hundred and fifty thousand years ago * the eccentricity of the earth's orbit was very nearly what it is now, and consequently the climate of these two distant periods, so far as it may depend on the eccentricity, was not very different. The eccentricity had been less, but was then increasing, and had so been for ten thousand years. It continued to increase for about fifty thousand years longer, becoming then nearly three times its present value. Then for another like period it diminished till it became about once and a half its present value. Then again for a second time it increased for about fifty thousand years, becoming about two and a half times the original value. This was one hundred thousand years ago. The decline again commenced, and eighty thousand years ago *the eccentricity was more than double its present value.* It is therefore evident—is plain as an axiom—that the Glacial period did not end then and there. The eccentricity continued to be greater than it is now for twenty thousand years more. And for this long period of *one hundred and ninety thousand years the eccentricity, on the average, was more than twice what it is now.* Those who disregard these facts have not fully grasped the question. It would better accord with truth to say that sixty thousand years ago the Glacial period was making ready "to go out of business."

If we allow only thirty thousand years for the undoing of the effects of the one hundred and ninety thousand—and the allowance is certainly moderate—the close of the Glacial period was only thirty thousand years ago, and that date is comparatively recent when counting geological time. It appears, then, that there is no irreconcilable difference between those geologists who reject Croll's theory by reason of the alleged remoteness of the Glacial period and those who think there "may be something" in that theory. And the more especially is this the case since the recent discovery of the old outlet of the upper lakes through Lake Nipissing and the Ottawa River and the relatively late period when the waters of all the upper lakes began to flow to the sea by way of the Niagara.

R. W. McFarland.

Columbus, Ohio, *February*, 1894.

* See American Journal of Science, August, 1880.

DOG PSYCHOLOGY.

Editor Popular Science Monthly:

Dear Sir: I was greatly interested in Mr. Monteith's article on "The Psychology of the Dog," in the February number, and desire to supplement his paper with some observations of a dog of my own. The animal was a pug—not full-blooded, but with a cross of some other kind; yet he had all the characteristic markings of that breed, and his general appearance was the same, except that his nose was a trifle longer and not so stubby.

"Gyp" was intelligent to a remarkable degree, and from some of his actions I firmly believe that he not only understood what was said to him, but he was capable also of continuous thought, and could reach conclusions. That he understood many words, and could distinguish between them, I am satisfied.

His mistress taught him that when some candy was placed before him, of which he was very fond, if she said, "That's Democrat," he must not touch it, but when the word "Republican" was uttered he at once ate it.

When "Gyp" was thirsty he would go into the kitchen and sit patiently at the sink waiting for a drink; but if, after waiting for

a reasonable length of time, no one came to supply his wants he would utter a sharp, impatient bark.

His happiest moments were when his master would ask him if he wanted to go out walking, and he would express himself very forcibly and unmistakably in the affirmative, and would, if asked at such a time, go to each member of the family, stand upon his hind legs, and give them each a kiss; or, if his master said to him, "Roll over, if you want to go walking," he would at once lie down and roll completely over.

But his reasoning or thinking powers were more clearly manifested in connection with a rubber ball with which he played, and which he would leave in various nooks and corners. When asked, "Where is your ball?" he would, if it was not in plain sight, bend his head down and stand for a moment as if in deep thought, and then proceed at once to get it, sometimes making a quick dive under the lounge, or in a bedroom, under the bed, or behind the curtains that separated the dining from the sitting room, always returning with it, and would look up into one's face, his very countenance intelligent with the answer, "Here it is."

His master generally putting him to bed at night, he usually lay upon the lounge, waiting for the time; and, after the fires had been replenished and the clock wound, he would get down and be ready to go. He invariably waited until the winding of the clock before preparing to start.

In an evil hour "Gyp" strayed away from home one day, and came back a badly used-up dog. He had evidently been attacked by some larger dog or dogs, and after lingering for nearly two weeks he died from the effects of the bites.

During this time he seemed really more like a "human being" than a brute. He was most patient and grateful for all the kind offices and helpfulness of his master and mistress, and heroically submitted to have his wounds washed and medicated, and, although at times scarcely able to walk, he insisted on being where his friends were, or where he could see them.

J. ANDREW BOYD.

ASHLEY, LUZERNE COUNTY, PA.

THE "BLUE LAWS" A MYTH.

Editor Popular Science Monthly:

"THE early Puritans of New England, who enacted the most ferocious of blue-laws, who would not let a man step over a stone in his path, or kiss—not his neighbor's but his own—wife on a seventh day," etc.

The above is a quotation from the very first page of an article, in the last number of The Popular Science Monthly, entitled Abolish All Prohibitive Liquor Laws, by Appleton Morgan. Now, these mythical blue laws never had any existence; no law forbidding a man to kiss his wife on the seventh day was ever on the statute-books of any New England colony. Prof. Johnston's History of Connecticut, in the American Commonwealths Series, or Palfrey's History of New England, will show the origin of this absurd myth. A glance at Blue Laws, and the Rev. Samuel Peters, in either Appletons' or Johnson's Cyclopædia will perhaps be enough for the ordinary reader.

Such careless misstatements naturally cause the reader to question the accuracy of the entire article. As you say in your editorial comments on the "young moon" error, "writers, and particularly writers on scientific subjects, are under obligations to know what they are talking about."

CHARLES E. DAVIS.

WASHINGTON, *February* 20, 1894.

EDITOR'S TABLE.

THE UNEMPLOYED.

WHEN a condition of things supervenes in which a considerable percentage of the population is cut off from the means of support by lack of work, we need not hesitate to say that something is wrong. We are not much in the habit of attributing purpose to Nature; but the language of teleology is sometimes convenient, and we shall perhaps not be misunderstood if we say that the apparently enforced idleness of thousands of men, with all the poverty and distress thence resulting, can not be part of Nature's plan, or at least can not illustrate the normal working of natural law. Nature, we know, is severe in her methods, and recks little of human life when she sets her forces of fire and flood, of storm and earthquake in motion. There is nothing analogous to these catastrophes in the social phenomena before us to-day. What we see is not the sudden extinction of human

lives by uncontrollable physical forces, but the prolonged misery of human beings through lack of adaptation to their circumstances or through the existence of artificial conditions of purely human production. To our mind the question of the hour presents itself in this shape: Why is there so terrible an amount of maladjustment in social relations today? Why are such multitudes so fatally out of harmony with the conditions of life? The symptoms, as we interpret them, all point to man's tinkering with natural laws in a futile effort to amend them, or with the shameful object of benefiting the few at the cost of the many. We wish briefly to indicate one or two of the ways in which, as it seems to us, social misery is caused.

It is recognized the world over that republican institutions are the definitive form of government for civilized countries; but when our forefathers struggled for liberty they probably had little idea of the form which popular government would in these latter days assume. They did not foresee the unrest that would be introduced into every section of the country through the desire to share in the emoluments which government has the power to bestow. They did not foresee the creation of a class of professional politicians who, reaping pecuniary rewards themselves for their political services (so called), would be empowered to dangle minor rewards before the eyes of scores of others by way of securing support for themselves. They did not foresee the greedy passions and the aversion to steady employment which all this would arouse, or the numbers of half-employed and unemployed men whom it would throw upon the community to live more or less the life of adventurers. They did not foresee the paralysis that would overtake both law and legislation through the balancing of selfish interests, or the deadness to large views of policy which the constant study of all political questions from a local standpoint would entail. While curbing the power and curtailing the privileges of a territorial aristocracy, they had no prevision of a moneyed class which, allying itself with the dominant party in the state, would wield a power more dangerous to national welfare than any aristocracy had ever done. We, however, see that all these things have come to pass, for we live in the midst of them and feel the burden of them every day. The remedy lies not in any reversion to outworn institutions—though diseased commonwealths have many times taken refuge in tyranny—but in the sedulous cultivation of a higher sense of citizenship. How is that going to be done? some one will ask. Do you believe in it yourself? we rejoin. Do you believe that the average sense of citizenship, or, to express it otherwise, the average sense of duty to the state, is low; and, if so, are you personally willing to set a higher example and courageously and strenuously uphold a higher doctrine? If so, you need not ask how the thing is going to be done, for you see the way yourself. If not, we do not wonder at your skepticism as to that being possible which you are personally unwilling to undertake. There are a hundred ways in which higher views of citizenship might be inculcated. The country is fairly riddled and honeycombed and worm-eaten with secret societies, the object of each being to confer special advantages on its members, the object of none being to raise the political and moral tone of the whole country. Could not some of the leaders of these move in the matter? Then there are schools, public and private, where ample opportunity exists for forming the minds of the young aright on this most important subject. Then there is the pulpit, which might be an enormous engine for good if rightly used.

The question just now, however, is how the dislocations which are causing so much misery have been brought about, rather than what specific meas-

ures are necessary to mend them. If we see whence our trouble has come, we shall not be at any serious loss as to remedies. The faults of our political system, or rather the vices which attend its practical working, are closely connected, in our opinion, with a defective system of popular education. The public-school system is a gigantic creation of law. It did not *grow* any more than the tariff; it was *made*, and made under the influence of arbitrary conceptions as to what a school system for the whole people should be. Being made for the whole people, special adaptations could not be thought of. Consequently, the work it does is like mill work, and all who come out of it show one uniform pattern. There is no cultivation of individuality, and, broadly speaking, all ideal elements are banished from the education imparted. The result is that the one really dominant trait in the swarms of youths sent out year after year from the public schools is a consuming desire to make money, and to make it in the easiest way possible. What the state has done is not so much to educate in any worthy sense, as to increase the keenness of competition by promoting an unnatural uniformity of tastes and aims. And, as the universal ambition is not only to make money but to make it fast and easily, it is not surprising that those who do not see how they are going to do this by honest means betake themselves to means that are not honest. It would be an interesting and instructive thing to know how many school-bred young men are at this moment engaged in various forms of "fake" business. What these individuals learned at school was that education was chiefly useful as a means of making money, and now they are trying to turn their education to such account as they find possible.

If habits of industry were taught in the schools, that alone would be a great gain; but in general it is not so. The idle have ample opportunity to idle, and even those who have no natural propensity that way are more or less habituated to idleness, owing to the simple fact that the teachers are not able to keep their classes fully occupied. That much moral harm is thus wrought to thousands of boys we have no doubt whatever. Then education is not valued, simply because it is apparently so cheap; and this again has a vulgarizing and demoralizing effect. Education ought to be valued, and, if it is not, it will be lacking in the moral virtue which it ought to possess. It may further be asked whether the drill of school renders those who are subjected to it more resourceful or less resourceful. Is there not a danger lest a habit be formed of looking for direction and not exercising individual powers of thought and will? We have no wish to dogmatize on such a question, but the conclusion to us is irresistible that the public-school system, as a whole, is a vast attack on the individuality of the rising generation, and that by destroying natural dissimilarities between the units of the population, and thus making competition fiercer, it throws a great number out of adjustment to their environment, either as destitute of employment or as in a manner compelled to some more or less criminal means of making a living.

It is a most unpopular thing, we are aware, to hint at the possibility of "over-education," but might we venture to suggest that there may be, and is in a multitude of cases, misplaced or superfluous education? A man not only does not need a university degree to enable him to drive a street car, but the possession of a university training is not likely to sweeten for him that particular kind of toil. We hold it to be entirely possible to supersaturate a community with university "advantages"; money liberally, vigorously, and unwisely applied will do it.

We fully believe that other elements than those we have indicated enter into

the problem of the unemployed. It is probably true, as hinted by Herbert Spencer in the address delivered by him in this city in the year 1882, that the pace set by the stronger and more competent members of the community is faster than the weaker ones can keep up with. "In the country of the blind the one-eyed man is king," and many of the "failures" of a civilized society might be brilliant successes in a society of a more primitive cast. So far as an unrestrained use by the strong of their superior abilities in competition for wealth and all that it represents may be an evil—and that it is an evil Mr. Spencer has again suggested in the last volume of his Principles of Sociology—we can only hope to check it by promoting the growth of higher moral and social sentiments. This will, in any case, take time; but meantime we should earnestly and sedulously consider in what directions and to what extent we are interfering with the operation of those natural laws the tendency of which is to produce a condition of social equilibrium. We need to open our eyes to the mischief we have done by a crude political philosophy, by unwise legislation, by indiscreet philanthropy, by the application of untried abstract ideas to the regulation of social questions. We need to awaken to a sense of the extreme liability of the human intellect to go astray when it attempts constructive work of any kind. That things have gone wrong we have the proof before our eyes, and where is the chief blame to be laid if not on our own short-sighted views and meddlesome policies?

It happened that just as we had finished the above article the Fortnightly Review for February was placed in our hands. The first article in the number is one by Herbert Spencer upon the late Prof. Tyndall; the second is by Goldwin Smith, and bears the title of Oxford Revisited. From the first, which will be found entire elsewhere in this number, we extract the following passage: "A conversation with him [Tyndall] some years since made it manifest that personal experience had greatly shaken his faith in public administrations, and made him look with more favor on the view of state functions held by me. On the other hand, my faith in free institutions, originally strong (though always joined with the belief that the maintenance and success of them is a question of national character), has in these later years been greatly decreased by the conviction that the fit character is not possessed by any people, nor is likely to be possessed for ages to come."

From the second article we take the following: "It may be said without reference to university extension or to any educational movement in particular, and it is to be hoped without incurring the charge of illiberality or obscurantism that people will have presently to consider the economical as well as the intellectual effects of pressing on everybody what is called high education. The good founder of Cornell University once confided to a friend his hope that the day would come when there would be five thousand students in his institution. His friend replied that if that day did come the institution, instead of being a blessing, would be in danger of being a curse, since there would not be a market for anything like such a number of graduates, and the residue would be without suitable work, unhappy, discontented, and probably dangerous to the commonwealth."

Whether we agree with these sentiments or not, let us ponder them. Of both writers it may be said that they are men of strong practical instincts.

WHY BENEFICENCE SHOULD NOT BE ENFORCED.

In a criticism of Mr. Spencer's Principles of Ethics in the January number of Mind, Prof. S. Alexander asks a question which, it seems to us, admits of an

easy answer. Referring to the position taken by Mr. Spencer that justice should, but that beneficence should not, be enforced, he asks why this should be, if the warrant for beneficence equally with that for justice lies, as Mr. Spencer seems to admit, in the public good. The answer we conceive is this: that while beneficence, wisely practiced, is a public benefit, the enforcing of it would not be a public benefit, inasmuch as it would tend to kill the sentiment itself. If, for example, the moment a beneficent action became possible for us some power should seize us and force us to a performance of the action, we can hardly imagine any other result than that the very instinct of beneficence would die out. Another answer is that whereas justice is essentially of the nature of non-interference, beneficence is essentially of the nature of interference. The motto of the one is "Hands off!" For the other we would have to coin the motto "Hands on!" Now, the difference between establishing in government the principle of "Hands off!" and establishing that of "Hands on!" is obvious. The former is not only workable, but is the necessary condition of all free individual effort; the latter is unworkable in any consistent manner, from its absolutely indefinite and unlimited character. If beneficence is to be enforced, where are we to begin and where can we possibly end? Again, imagine the effect on weak individuals of knowing that beneficence toward them will be enforced. What interest have they henceforth in ceasing to be weak? Finally, beneficence administered by the state is not beneficence in the true sense, and can have none of the effects of true beneficence; for the state can only properly take what it has a right to take and give what it has a right to give, and the beneficiaries in the case supposed would be quick to draw the inference that they were getting no more than their due. Thus would the limits of justice be obscured and social stability endangered. On many grounds, therefore, we think the distinction Mr. Spencer draws a sound one.

POINTS IN LIBRARY MANAGEMENT.

The report of the Library Committee of the Public Library of Cleveland, Ohio, for the year ended August 31st last, has come into our hands. Two remarks made in it have arrested our attention. One is to the effect that "it is a singular and deplorable fact that, of all the money so lavishly expended by the many rich men and women of Cleveland in various benevolent and charitable enterprises, not one cent has ever been given either toward the erection of a library building or to help to support the library." Elsewhere it is stated that "our library has never had the use of any money except such as came by taxation."

Well, whether or not there is anything "deplorable" in this, we can not say that we find the fact at all "singular." Taxation and benevolence are two things that do not naturally mingle. The Cleveland Public Library seems to have been in operation since 1869, and it has doubtless come to be looked upon as a department of the city government. Had taxation not been resorted to for the formation of a library, there is no knowing what private beneficence might not have done ere this. When the State takes up a function, it is a kind of hint to private enterprise to drop it. Why should a private individual subsidize a tax-supported library any more than a tax-supported post office?

The other remark above referred to is that "the plan of permitting free access of patrons to the shelves, adopted some time since with some misgivings, continues to give increased satisfaction to those using the library. . . . Not only," the report continues, "has this new method given great satisfaction to those desiring and drawing books from the library, but it has also enabled us to

issue more books with very much less labor and expense than under the old conservative system which previously prevailed. Nor has this free access to the shelves resulted in loss of books or damage to the same." This statement is very satisfactory. Many of the restrictions which surround public institutions and which hamper the work of government are general rules adopted to meet very limited evils. Instead of meeting the limited evil and overcoming it by watchfulness and such special measures as may be called for, a general rule is adopted which operates as a burden on a large number of persons for whom no such rule is necessary. Such is the stupid instinct of governments always and everywhere, we might almost say; and it is also one of the chief ways in which government is rendered expensive, as the authorities of the Cleveland Public Library seem to have found out. We congratulate them on having made a useful discovery, and we trust that their experience will lead other similar institutions into the right path.

One little observation before we leave this topic. In the list of newspapers and periodicals on file in the reading room of the library we notice but one in the French language, and that is—what? The Revue des Deux Mondes, or the Nouvelle Revue, or the Revue Bleue, or even the Courrier des Etats-Unis? No, but the Mode de Paris. All that French periodical and newspaper literature contributes to this tax-supported institution is a fashion paper. May we suggest that, if a German one is wanted, Modenwelt is not bad in its way. Let literature flourish!

LITERARY NOTICES.

GENETIC PHILOSOPHY. By DAVID JAYNE HILL. New York: Macmillan & Co. Price, $1.75.

THE author of this work undertakes to treat the principal problems of philosophy by a method which, though he does not assert it to be entirely new, he does not believe has been systematically carried out by any previous writer. He applies to his method the term "genetic," and he explains that it "consists in referring every fact to its place in the series to which it belongs." Such a method, of course, is essentially the method of science, and what we recognize in the work before us is not so much any originality of method as a skillful and interesting application of a well known method to a number of interesting and important philosophical questions. There is nothing, for example, very original in the following declaration of principles, but it is well expressed: "Being, as apprehended by our intelligence, is found to possess continuity, and all facts are the aspects of a process. When, therefore, facts are translated into thought, they must not be sundered and isolated, floated off from their attachments and treated as independent entities. The continuity which connects them as real must also connect them as ideal. In other words, they must be genetically regarded, or considered as aspects of a continuous process to which they must be referred."

Among existing philosophical schools that to which President Hill most inclines is evidently the evolutionist as represented by Herbert Spencer. He criticises the latter, however, for placing the Unknowable in the forefront of his system, and then afterward hustling it out of court as "deserving of no consideration from the minds of adults." We can hardly admit this to be a correct account of Mr. Spencer's procedure, but the point is not one that admits of discussion in this place. He says, again, that to Mr. Spencer "the universe is like a great music-box which can play but one tune." How many tunes, one might ask, does a strictly "genetic" philosophy provide for? Any limitation in this respect must come from the recognition of necessary sequence, and such recognition is as much a feature of our author's mode of thought as of Herbert Spencer's.

On the subject of the Genesis of Matter, which constitutes the first chapter (following the Introduction) of Mr. Hill's book, we are not told anything new, or rather we are not told anything at all; what we are told relates entirely to the supposed constitution of

matter, a somewhat different thing. What the author has to say, however, he says well, and the whole chapter constitutes an interesting exposition of modern views in regard to the material universe. It is a mistake to say, as he does on page 48, that "it was Bode's law which led Leverrier and Adams to assign a position to an unknown planet from the anomalous movements of Uranus." Bode's law simply assigns approximately the distance from the sun and from one another of the planets of our system, but says nothing as to the position in its orbit which a given planet shall occupy at a given time; and in searching for the undiscovered planet its position in its orbit and not its distance from the sun was the point to be determined. The chapter is concluded with a verse from Omar Khayam:

"Shall any gazer see with mortal eyes,
Or any searcher know by mortal mind?
Veil after veil will lift—but there must be
Veil after veil behind."

So far, therefore, as the genesis of matter is concerned, the Persian poet of nearly a thousand years ago expresses the thought of the "genetic" philosopher of to-day.

In Chapter II, on The Genesis of Life, the author frankly and fully accepts the doctrine of evolution. "At present," he says, page 63, "there is probably no biologist of importance who does not accept organic evolution as a real process of Nature, although there are various degrees of conviction as to the sufficiency of the explanation of the causes which have been operative in the natural history of descent." As between the conflicting views of Weisman and Spencer, Mr. Hill rather inclines to the side of Spencer, but we do not judge that he speaks as a biologist, or that he has mastered all the arguments on either side of the question; at the same time the discussion, considering the limits within which it is confined, is ably done and will be useful to the general reader. Under the head of The Genesis of Consciousness, again, we have an interesting review of modern speculation respecting the conditions of consciousness, but no really distinctive view as to its origin. The author states his conclusion to be that "while psychic elements are manifested to us directly only through consciousness, they exist as its preconditions; and, therefore, are not to be denied existence beyond the sphere of consciousness." Goethe had said as much in his celebrated aphorism that Nature "sleeps in the stone, dreams in the animal, and wakes in man." Schopenhauer too, makes Will, which is decidedly a psychic element, pervade the whole universe. "Unless every analogy of Nature is violated," observes the author, "what we call the 'soul' had its being long before it came to consciousness"; and holding this view it is not to be wondered at that he looks with decided favor on the doctrine of metempsychosis.

The remaining chapters of the book deal with the Genesis of Feeling, of Thought, of Will, of Art, of Morality, of Religion, and of Science. All are characterized by liberality of thought and are interesting in a high degree. There is excellent matter in all these chapters, particularly in those on Will, Morality, and Religion. The author denies that pleasure is Nature's end, asserting that it is merely Nature's means toward higher ends, a view which we think has much to commend it. On the subject of the connection or relation between (physical) energy and will he takes up much the same position as Schopenhauer. "By what right," he asks, "is the objective series elevated to the dignity of a causative order and the subjective series regarded as inconsequential?" As regards the development of morality, he seems to accept Herbert Spencer's analysis as far as it goes, but finds it too abstract, too merely schematic, if we may use the expression. His own statement of the matter is that "the evolution of morality is the gradual formation of a moral consciousness through the perception of what is *due* in the relations of social life." Sin he defines as "the persistence upon the human plane of tendencies which belong to the animal plane, and which should therefore have been subjected to the law of reason. From the moral point of view," he adds, "to be carnally-minded is death." In the chapter on the Genesis of Religion the author holds that, while Mr. Spencer's theory which assigns the origin of all religion to ancestor worship will explain much in the way of religious ceremonial the world over, it will not explain everything, and particularly will not explain the origin of the religious sentiment.

"The order and progress of the world," President Hill maintains, "the ideals which press upon us for realization—these are the secure foundations of religious faith. The unity of the world, the immanent rationality of its processes, the beneficence of law, the imperative authority of duty—these are the corner stones of religious life and hope." His own definition of religion, however, is "belief in a superhuman being or beings regarded as objects of worship"; and the question is how, without some such hypothesis as Mr. Spencer's, or without a primitive supernatural revelation—a conception which the author puts aside as totally insufficient and having only a verbal meaning—to explain the origin of such belief. That question we do not consider he has solved. In concluding this notice we leave many interesting points untouched; but we wish to say that the book as a whole has great merits; it is perspicuous and scholarly in style, vigorous in thought, candid in tone, excellent in matter, and altogether a very creditable addition to American philosophical literature.

A THEORY OF DEVELOPMENT AND HEREDITY. By HENRY B. ORR, Ph. D., Professor at the Tulane University of Louisiana. New York and London: Macmillan & Co., 1893. Pp. ix+255. Price, $1.50.

THE author states in his preface that he believes that by a critical review of the facts of biology in the light of the great conclusions derived from the allied sciences of physics and psychology we may obtain a view of the great phenomena of life that shall bring into harmony a more extensive range of facts, and explain intelligibly relations that have hitherto been hidden.

He sums up a scheme of the course of development by premising a primitive mass of protoplasm which acquires nervous co-ordinations that influence its activity and growth: as it divides and redivides, it adds continually new co-ordinations to those already acquired, and by repetition the process of growth and development has the character of reflex action. As the same forces act on each generation, and form a series of stimuli that are similar for each generation, so each generation repeats in its life the course of development followed by all its ancestors. These different phases of one process constitute his explanation of growth, development, and inheritance. According to this, in our own development we must recognize ourselves and our actions as the result of a definite, accurate activity of creative force.

The author sees what is the last analysis of such a theory of development and life, that our ideas of free will and moral responsibility are paradoxical: but we do not see on what grounds he believes such a paradox is capable of satisfactory solution, even though we are all convinced that we have a certain degree of freedom of will. Would it not be better to abandon the idea of free will and hold that will is the expression of hereditary tendencies modified by environment—a theory that, at present, the author strongly inclines to?

Prof. Orr's book is interesting, and is a satisfactory explanation of the evolutionary theory of development and heredity.

LECTURES AND ESSAYS ON FEVERS AND DIPHTHERIA, 1849 to 1879. By Sir WILLIAM JENNER, Bart., G. C. B., M. D. Lond., and F. R. C. P., D. C. L. Oxon., LL. D. Cantab. and Edin., F. R. S., etc. New York: Macmillan & Co., 1893. Pp. xii+3 to 581. Price, $4.

THIS volume is a collection of papers that the author published between 1849 and 1879 in various medical journals of Great Britain.

The first essay, on the identity or non-identity of typhoid and typhus fevers, is dated 1849–'50, and is founded on a statistical analysis of a series of cases observed during two years at the London Fever Hospital.

The second essay is devoted to proving that the causes of typhus, of typhoid, and of relapsing fever are separate and distinct, a fact by no means currently accepted in 1849. This topic is further elucidated in the third essay.

The fourth essay, on the acute specific diseases, formed the Gulstonian Lectures of 1853.

The second section of the volume consists of three clinical lectures, two on diphtheria and one on croup and diseases that resemble it.

All these essays demonstrate the careful and critical observation displayed by the author in his clinical work, and the volume

forms a useful contribution to the history of medical progress in the nineteenth century.

A Text-book of Physiology. By M. Foster, M. A., M. D., LL. D., F. R. S., etc. Sixth edition. Part I, comprising Book I. Blood; The Tissues of Movement; The Vascular Mechanism. New York and London: Macmillan & Co., 1893. Pp. 387. Price, $2.60.

The popularity of this text-book is evidenced by the fact that a few months after the final part of the fifth edition was published the author presents the first part of the sixth edition. We find but few changes in the present volume except in the chapter on the vascular mechanism, in which descriptions have been introduced of the membrane manometer of Hürthle, of Stolnikow's method for determining the quantity of blood ejected by the ventricle, and of the cardiometer of Roy and Adami. In a number of sections the text has been rearranged, but with no additions that are of signal importance.

Essays by Thomas H. Huxley. Vol. I. Method and Results. Pp. 430. 1893. Vol. II. Darwiniana. Pp. 475. 1893. Vol. III. Science and Education. Pp. 451. 1894. New York: D. Appleton & Co. Price, $1.25 each.

These are the first volumes of a series intended to include the collected essays of Mr. Huxley. The first contains a brief but characteristic autobiography, and nine essays that were published between 1866 and 1890. The author states that while they are neither free from repetitions nor, perhaps, deficiencies, yet as far as their substance goes he finds nothing to alter in them. This, we opine, is rather an evidence of the soundness of his opinions than of failure to make progress in wisdom during the last quarter of a century.

The essays include that on the advisableness of improving natural knowledge, that on the progress of science, on the physical basis of life, on Descartes's discourse touching the method of using one's reason rightly and of seeking scientific truth, on the hypothesis that animals are automata, on administrative nihilism, on the natural inequality of men, on natural and political rights, and on government.

The second volume contains essays on the ancient doctrine of evolution, rehabilitated and placed upon a sound scientific foundation, since and in consequence of the publication of the Origin of Species. These essays meet the criticisms imposed upon Mr. Darwin's great work, and sum it up and indicate its enduring influence on the course of scientific thought. The volume includes three essays—on Charles Darwin, on the Darwin memorial, and an obituary of Darwin—that record the impressions left by that scientist on his friend for thirty years, the author of this volume.

The third volume contains seventeen essays that were published between 1854 and 1887, all of which refer to the value of science in education.

Some of these essays have appeared in pages of the Monthly, but the many admirers of Prof. Huxley will be glad to welcome this permanent collection of his writings that have done so much to advance the scientific spirit of our age.

Jesus and Modern Life. By M. J. Savage. With an Introduction by Prof. Crawford H. Toy. Boston: George H. Ellis. Pp. 229.

In this work the author has sought to find out, so far as is to-day possible, the actual beliefs and teachings of Jesus. Then, having, as he has supposed, had this teaching, he has considered it as relating to the preceding thought of the world, and specially of his own people. After that he has tried to find out how much of this teaching is vital to-day, and how it bears on the problems, religious and other, with which we must deal. "Only in some such way as this," he assumes, "can we really find out to what extent and in what sense Jesus is a present leader and inspiration."

The New Bible and its New Uses. By Joseph Henry Crooke. Boston: George H. Ellis. Pp. 286.

In this book the Bible is considered in the light of the modern or "higher" criticism, by which, the author holds, the theories of our fathers respecting its origin, growth, and character have been swept aside. As a result, "we see with greater clearness the impulse and purpose which produced these writings. We understand the

human conditions which gave them birth, the limitations as well as the nobility of the authors who penned them. We appreciate the greatness of their varying messages, but we also trace the burning lines of error and passion which mar these pages. There is truth enough to make them grandly human; there is superstition enough to prove them no more than human."

A HISTORY AND DESCRIPTION OF THE MODERN DOGS (SPORTING DIVISION) OF GREAT BRITAIN AND IRELAND. By RAWDON B. LEE. London: Horace Cox. Pp. 584, with Twenty-six Plates.

THE author has attempted in this book to summarize the progress and describe the varieties of the sporting dogs as they are at present known and appreciated in the British Isles. Without losing any of the early history, his wish has been to introduce matter bringing the subject up to date; both so far as the work of dogs in the field is concerned, and in viewing them as companions, and when winning, or attempting to win, prizes in the show ring. After this method full accounts are given of twenty-nine varieties or "sports" of dogs, with historical information, anecdotes, gossip of the market and the kennels, discussion of values, the points by which the kinds are distinguished, and qualities; constituting the book of great value to all who are interested in breeding, using, or admiring dogs. Of the illustrations, only two —those of the greyhound and of the Kerry beagles—are actually portraits. The others, though originally drawn from living examples, are rather typical specimens of the various breeds they represent.

OBJECT LESSONS AND HOW TO GIVE THEM. By GEORGE RICKS. First Series. For Primary Schools. Pp. 202. Second Series. For Intermediate and Grammar Schools. Pp. 214. Boston: D. C. Heath & Co. Price, 90 cents each.

THE primary purpose of lessons in common objects and natural phenomena, the author believes, is to cultivate the senses, to train the habits of attention, intelligent observation, and accurate comparison, and so lead up to the higher processes of the mind —reason and judgment. The natural course of the teacher would seem to be to gather up into something like order and to perfect what has so far been imperfectly accomplished by the child, and to evolve from this as a basis a systematic course of training; and the teacher who would best succeed should take childhood's method of imbibing knowledge and adapt it to her own use. The child, as Spencer says, should not be told or shown, but taught how to observe. The lessons in the first series are intended to be short, simple, pleasing, and attractive, and relate to objects of sense, common articles, and the simpler qualities. Those of the second series relate to the common properties of solids, liquids, and gases, in that order, and to those matters which demand closer observation and exercise of the reasoning faculties. They are suggestive rather than exhaustive.

SUICIDE AND INSANITY: A PHYSIOLOGICAL AND SOCIOLOGICAL STUDY. By S. A. K. STRAHAN, M. D., Barrister-at-Law, etc. London: Swan, Sonnenschein & Co., 1893. Price, $1.75.

THE author states that he has endeavored to trace modern suicide to its source, to show how large a percentage of what is really avoidable is deliberately propagated, and how closely it is related to those other abnormal conditions met with in all civilized communities. The cause of suicide is cultivation, and it is propagated by the intermarriage of the insane, the epileptic, and the criminal.

Suicides are divided into two major classes—rational or quasi suicide and irrational or true suicide. The former class is further subdivided into, first, those who destroy their life for gain, consisting of religious devotees, of those who die to follow friends, of those who die to gain notoriety, and of those who die that others may gain. Second, those who commit the suicidal act that they may escape some real and impending evil that is considered more terrible than death.

Irrational suicides are divided into three groups: First, that in which there is mental aberration; second, that in which the act depends upon an irresistible impulse and in which there is no mental aberration; third, that in which a certain predisposition makes it possible for a slight shock, trial, or irritation to awaken the unnatural impulse.

As statistics show that suicide is on the

increase among all civilized peoples, whether their racial predisposition be great or small, and as racial proclivity remains fixed, the author concludes that all, or nearly all, the increase must be the outcome of the acquired or pathological character.

The influences of race, of climate and season, of religion, and of sex and age are considered as factors in causing suicide.

In regard to the stand taken by the law in reference to suicide, the author says that he does not believe that pronouncing suicide a crime has ever stayed the hand of a single individual bent on self-destruction, and the law has never been able to punish the criminal in a single instance, nor can it hope to. There are only two logical courses open to those who would reform this legislative absurdity. One is to sweep away all legislation upon the subject so far as it relates to the individual himself, no longer consider suicide a crime, and ignore attempts thereat. The other is to enact that all attempts at suicide, whether successful or not, be in themselves conclusive evidence of dangerous insanity. The author, agreeing with the Sophists, Stoics, Epicureans, and Platonists, believes that the first of these two is the more just and sensible course.

The author considers the theological, naturalistic, sociological, and moral objections to suicide, and concludes with old Dr. Donne that "self-homicide is not so naturally sin that it may never be otherwise."

The author has presented a very interesting and unbiased study of a topic that is engaging more and more attention, for it is not one of the least of the charges against modern society that its organization is such that men and women are unwilling to continue as associates thereof.

THE TECHNIQUE OF POST-MORTEM EXAMINATION. By LUDVIG HEKTOEN, M. D., Pathologist to the Cook County Hospital, Chicago. Chicago: The W. T. Keener Company, 1894. Price, $1.75.

THE author is to be congratulated on this little work that is a concise exposition of the various matters connected with the performance of post-mortem examinations. He has not endeavored to enter into a systematic and minute consideration of the pathological changes in the organs, but rather he has made it his aim to give such general and comprehensive information as is needed by the examiner.

As no State in the Union has prescribed regulations to guide and direct the practitioner in the method of making necropsies in medico-legal cases, it is believed that the systematic procedure detailed in this book will make it useful to all practitioners of medicine likely to be called upon to perform such duty.

The work is admirably printed and illustrated, and is one of the best books on this topic with which we are acquainted.

MYTHS OF GREECE AND ROME. By H. A. GUERBER. New York: American Book Company. Pp. 428. Price, $1.50.

STUDENTS of literature and art will find a most attractive handbook in this volume.

While it does not take the place of a dictionary of reference, where every dryad may be traced to her favored tree by the classical scholar, it includes all the more important myths celebrated in song, sculpture, or painting.

The illustrations alone comprise seventy-one reproductions of famous works of art. The text is bright and interesting, and in conclusion an analysis of myths is given, the philological interpretation receiving the preference. The work is also generously furnished with aids to the reader, containing a classical map and genealogical chart as well as glossary and index.

WILLIAM KITCHEN PARKER, F. R. S. A. BIOGRAPHICAL SKETCH. By his Son, T. JEFFERY PARKER. London and New York: Macmillan & Co. Pp. 145. Price, $1.50.

ALTHOUGH naturalists generally are impelled to their life work by an ardent love of Nature, it is rare to find among them in early youth such glowing enthusiasm as that exhibited by William Kitchen Parker.

The son of an English farmer, only a scanty education had been afforded him when he began, as a lad, his loving study of bird and flower in his father's field. Apprenticed at the age of fifteen to a druggist, he read physiology while compounding sheep ointment, and rose at four o'clock in the morning to have three hours' botanizing in the woods. In two summers he had collected

and preserved five hundred species of plants, and laid the foundation for a thorough acquaintance with botany. He was next placed with a country surgeon, and here undertook by himself the study of comparative anatomy, dissecting animals and birds, and executing drawings of marvelous exactness and beauty. It may well be credited that at fifty years of age he had produced more original work than any other English anatomist. His zest for knowledge and keen enjoyment of Nature never waned. At sixty-five he writes: "The sight of the wild flowers, the settling of a speckled, metallic feathered starling close to me, and the song of the lark made weariness a trifle; . . . the joy of research has been the wine of my life." A characteristic portrait is the frontispiece to the memoir, and a list of published works is given at the close, these being mainly upon the foraminifera, the vertebrate skeleton, and skull.

HANDBOOK OF PUBLIC HEALTH AND DEMOGRAPHY. By E. F. WILLOUGHBY, M. D. London and New York: Macmillan & Co. Pp. 495. Price, $1.50.

THIS volume constitutes the third edition, enlarged and revised, of a former work, the Principles of Hygiene, by the same author.

The subject is treated in four main divisions—health of the man, health of the house, health of the city, and health of the people. In addition to these there are chapters on demography, meteorology, and sanitary law.

Much space is given to the section on dietetics, where somewhat of the changes involved in nutrition are explained according to the experiments of Pettenkofer and Voigt. The prevalent error is noted of confounding oxidation with metabolic processes in the body. The value of a food depends upon the ease with which it digests, splits up, and combines in the organism, not upon the constituents *per se*.

Common snares are also pointed out in the food that does not nourish, the filter that is worse than useless, the barometer which measures nothing, the disinfection that does not disinfect, and the statistics that prove a trap for the unwary. But the effort of the book is mostly constructive, and there is much in it that is valuable for the student of statistics and the householder. The unfortunate schoolgirl may, if it falls into her hands, drop it with righteous scorn. The chapter on school hygiene is disfigured by a thrust at feminine ability and the threadbare plea that woman's health suffers in the educative process. The author, illogical enough, gives the best possible reply to this in his dissertation on exercise, where he informs us that most of the ailments of women would be prevented if girls strengthened their muscles as their brothers do!

The Child, Physically and Mentally, is considered by *Bertha Meyer* in a small pamphlet translated from the German by Friederike Salomon and published by the M. L. Holbrook Co. A similar work was written by the author thirteen years ago, and this is intended as a supplement, embodying the more recent teaching of hygienic science. It is curious to note that it contains only two pages of suggestion for the mother who desires to rear her child in the natural way. This is certainly not all that should be said on the subject in a country where infant mortality is exceptionally high. An appendix is needed to justify the aim and title of the *brochure*.

The Arithmetic of Magnetism and Electricity, by *John T. Morrow* and *Thorburn Reid*, a little handbook of 145 pages, consists of the statement and explanation of those facts and laws of electricity and magnetism which are especially connected with their practical and commercial aspects. It contains among other matters chapters on General Laws of Electric Circuits; Batteries, Primary and Secondary; Direct-current Dynamos and Motors; Alternating current Dynamos, Motors, and Transformers; Lighting and Power, and The Application of Electrical Laws to Electrical Railways; with some useful tables. (It is published by the Bubier Publishing Company, of Lynn., Mass., at $1.)

A System of Analysis of Milk and Milk Products, containing results of the latest researches, is given us by *Leffmann* and *Beam*. Most of the earlier processes have been superseded or at least greatly modified in the past few years by the large amount of original work done, more especially under the supervision of the Society of Public Analysts. The book is intended not only for professional chemists, but also for practical dairymen, and to such it ought to prove

a great aid. It contains an appendix consisting of useful tables for calculating total solids, etc. (It is published by P. Blakiston, Son & Co., Philadelphia. Pp. 89. Price, $1.)

A collection of *Bulls and Blunders*, compiled by *Marshall Brown* (Griggs, $1), has recently been issued. It is a large and amusing collection, and besides being amusing it is instructive, for where the blunder consists in a faulty arrangement of words, the way to correct it is pointed out.

Under the title, *The Monism of Man*, *David Allyn Gorton*, M. D., has put forth a mingled mass of scientific facts and supernatural speculations (Putnam, $2). The book is a hard one to describe. It is not a descriptive treatise on the subject indicated by its title, for it does not even tell anywhere what the "monism of man" is. It can not be called a disputation, for it does not attempt to prove anything in particular. It is rather a pleasant, extended essay, in which a man versed in a scientific profession and well read in classic literature and religious lore has set down some things that he knows and others that he believes, together with many quotations from favorite authors, and his own reflections upon the material thus brought together.

From the University of far-away Tasmania comes, by way of an English printing office, an essay on *Utility of Quaternions in Physics*, written by *A. McAulay*, in competition for a prize offered by the University of Cambridge (Macmillan, $1.60). In a long and free-spoken preface the author states that the physical applications of quaternions are sadly neglected at Cambridge, in spite of Prof. Tait's powerful advocacy. He ranks himself as a disciple of Prof. Tait in promoting the study of this branch of mathematics, but feels compelled to differ from his master on certain points, some of which he sets forth in his preface. The divisions of physics to which he applies quaternions in this essay are elastic solids, electricity and magnetism, hydrodynamics, and the vortex atom theory. At the risk of being deemed a misdirected enthusiast he hopes for a "time when quaternions will appear in every physical text-book that assumes the knowledge of (say) elementary plane trigonometry."

In the *Elements of Life Insurance*, the author, *Miles M. Dawson*, has sought to give the reader a comprehensive and accurate conception of life insurance, without burdening his mind with needless technical terms; to write what will be most useful to beginners and so as to be intelligible to the general public mind. Besides the analysis of rates and reserves, the scope of the book covers the subject of contracts; their construction, application, nature, and legal effect. Insurance is defined as the equalization of fortune. By its provisions, a large number of men arrange to lose small sums in order that none of them may lose a great sum in a specified way. Thus it is the alliance of prudent men against misfortune. The book is published by the Independent Printing and Publishing Company, Chicago, at the price of two dollars.

The Outlines of Embryology of the Eye—the Cartwright Prize Essay for 1893—by Dr. *Ward A. Holden*, is the product of a study carried on at the New York Ophthalmic and Auric Institute, and is based upon the examination of a great number of specimens of eyes of chicks and pigs. Endeavoring to give a clear and comprehensive description of the development of the organ, the author has deemed it best to present first a brief and purely schematic sketch of the processes which take place, explaining them with diagrams, and next to give an accurate histological description of the various parts of the eye in their successive phases of development, illustrating these descriptions with careful drawings from actual preparations. (Published by G. P. Putnam's Sons. Price, 75 cents.)

Under the title *Manual of Linguistics* a great amount of material on the phonology of English and other languages has been brought together by *John Clark*, a master in the High School of Dundee (Putnam, $2). After an introductory chapter on the culture and original home of the Aryans, the sound relations in the Indo-European languages are considered at some length. From this subject the author passes to various modifications of vowels and consonants, such as assimilation, shortening, lengthening, prothesis, epenthesis, contraction, labialism, dentalism, rhotacism, reduplication, etc. The nearly related topics ablaut and accent are next considered. The operation of Grimm's law

is then set forth, and the volume ends with two chapters on sound relations in Anglo-Saxon and in middle and modern English. The several laws and processes set forth in the volume are abundantly exemplified by illustrative words.

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POPULAR MISCELLANY.

Spencer-smashing at Washington.—At a meeting of the Washington Society for Philosophical Inquiry held January 23, 1894, the Rev. Dr. Momerie, of London, read a paper on Agnosticism, consisting chiefly of a criticism of Mr. Herbert Spencer and a defense of the current dualistic conception of the soul as the thinking personality or ego considered as distinct from and independent of the body. The paper was discussed by Dr. W. T. Harris and Mr. Lester F. Ward. Mr. Ward's remarks were as follows: "While Dr. Momerie was reading his able paper I could not help thinking to what a remarkable degree the views of Herbert Spencer have become the object of philosophical discussion and public attack. To judge from the opposition to him in all directions one would suppose that his entire system of philosophy was unsound and worthless. No book, no philosophic essay, no form of discussion of any question is complete that does not score him at some point. This society since its organization a year ago has been engaged in an almost uninterrupted onslaught upon his doctrines. Dr. E. L. Youmans, who, when living, was the great American disciple of Spencer, used to characterize those who even at that date had begun to inveigh against him by the name of 'Spencer-smashers,' and since his death the business of Spencer-smashing has continued to increase; but, strange as it may seem, notwithstanding all this opposition the great philosopher will not down. I am not myself innocent of the charge of Spencer-smashing, and I thought these remarks

would come with a better grace from the fact that I have just published what will probably be considered a somewhat severe criticism of Herbert Spencer's Political Ethics. But I am not unmindful of the astonishing power that he has become in the thought of the world, which renders any utterance of his wherein he is wrong so potent for evil. I recently asked a student of Oxford, here for a few days on his winter vacation, how Spencer was regarded at Oxford, and he told me that although his name was rarely spoken and then only in a whisper, as if, on Pope's theory of vice in general, its very utterance might lead to closer acquaintance, nevertheless Spencer was the unseen but overshadowing presence that surrounded the university and which it was considered necessary perpetually to guard against and drive back. I am not finding fault with the widespread opposition to Spencer. Nothing could be worse than to set up a high priest of opinion and bow down to authority. But I have often been amused to see how simple a matter it is supposed to be to refute his doctrines and overthrow his system. And I am disposed to attribute the solidity of his system, and the wonderful resistance which it offers to this perpetual bombardment, to the high degree in which it rests upon the firm foundations of truth. I am myself disposed to follow him with little deviation all the way until he reaches deductive sociology and ethics, and I leave him here only because I believe that, owing to unfortunate early political preconceptions, he has himself left the clear path which his entire system logically requires him to follow. But I did not rise either to approve or disapprove Spencer's philosophy, but simply to draw attention to the kind of man the world has to deal with when it ventures to antagonize his achievements. He fills no chair in any great university, he bears no title from the English crown, he holds no high post of public honor, he boasts no classical scholarship, he speaks no language but his mother tongue, and yet, by a complete mastery of that tongue, and by the sheer power of vigorous and organized thought applied to an 'encyclopedic' acquaintance with all that is worth knowing in the world, he has forced his way into every department of human thought and action. He has invaded science, art, philosophy, literature, morals, and religion in a way and with an authority that have commanded respect and attention, until to-day the eyes of the whole thinking world are centered upon him. I did not know but that Americans were alone in rendering him this unintended homage, but I have learned to-day that it is also the habit of his own countrymen."

The Land of Kashmir.—Giving an account of his Karakorum expedition, Mr. W. M. Conway said that the actual Kashmir was widely different from the land full of all material delights and scenes of idyllic beauty which poets had described. It might, in truth, be described as a "crumpled Sahara," with rocks and precipitous slopes, stony, naked, devoid of moisture or of shade, a grilling, hopeless, impassable wilderness. The only relief to its absolute desert were the patches of artificial irrigation. In this inhospitable region there were great masses of mountains covered with snow, from which sometimes streams issued which created oases here and there of singular fertility. In them alone was any population to be found. The starting point of the expedition was Gilgit—now an important military outpost, but a few years ago unknown to British travelers. Gilgit is about five thousand feet above sea level and affords an exaggerated example of the climate of these regions. It was almost rainless during the months of May and June and the earlier part of July. He had just received a letter from a British officer stationed at Gilgit who gave him a vivid account of a terrible flood which occurred on July 7th and in the course of five days wrought a positive geological revolution. All the bridges and piers were destroyed, and the engineers had to extemporize a bridge with a span of three hundred and forty-six feet. From this cheerless region he emerged into a land of glaciers and traversed the great Hispar, Baltoro, and Biafro glaciers. These great snowfields resembled—though planned on a much vaster scale—those of the Alps. Besides the snowfields there were great areas of moraine—inhospitable deserts covered with large masses of broken stone. There sprang up from them mountain peaks ranging from twenty thousand to twenty-eight thousand feet. In the

Karakorums there were about half a dozen peaks over twenty-four thousand feet. He had himself climbed one of twenty-three thousand feet. These mountains were very different from the Alps, and were mostly in the form of gigantic towers of incredible sharpness—a form in marked opposition to the rounded masses which were the prevalent form of the European mountains.

Distribution of Birds.—The question of the distribution of birds was cited by Canon Tristram, President of the Biological Section of the British Association, as a sphere in which the field naturalist can work to great advantage in studying the operation of isolation in the differentiation of species. Taking as typical examples the Sandwich Islands, thousands of miles from the nearest continent, and the Canaries, within sight of the African coast: in the one we may study the expiring relics of an avifauna completely differentiated by isolation; in the other we have opportunity of tracing the incipient stages of the same process. In the Sandwich Islands there is hardly a passerine bird in the indigenous fauna that can be referred to any genus known elsewhere; and it is now recognized that almost every island of the group possesses one or more representatives of each of these peculiar genera. That each of the islands of this group, however small, should possess a flora specifically distinct suggests thoughts of the vast periods occupied in their differentiation. In the Canary Islands the process of differentiation is only partially accomplished. Yet there is hardly a resident species which is not more or less modified, and this modification is still further advanced in the westernmost species than in those nearest to Africa. We have here the effect of changed conditions of life in four hundred years. What might they not have been in four hundred centuries? The avifauna of the Comoro Islands, to take another insular group, seems to stand midway in the differentiating process between those of the Canaries and the Sandwich Islands. The little Christmas Island, an isolated rock two hundred miles south of Java, only twelve miles in length, has been shown by Mr. Lister to produce distinct and peculiar forms of every class of life, vegetable and animal. Though the species are few in number, yet every mammal and land bird is endemic. In the year 1857–'58 the speaker spent many months in the Algerian Sahara, and noticed the remarkable variations in different groups, according to elevation from the sea and the difference of soil and vegetation. The Origin of Species had not then appeared; but on his return his attention was called to the communication of Darwin and Wallace to the Linnæan Society on the tendencies of species to form varieties, and on the perpetuation of varieties and species by means of natural selection. He then wrote, citing these variations as supplying illustrations of Darwin's and Wallace's theory, but suggesting that, instead of the blending of forms being caused by the two races commingling, rather while the generalized forms remain in the center of distribution, we find the more decidedly distinct species at the extremes of the range, caused not by interbreeding, but by differentiation.

Common Sense on the Labor Question.—The clear light of pure common sense is thrown upon some of the features of the labor agitation in the comments of the London Times upon a conference recently held at Westminster Abbey to consider the troubles in the collieries. The friends of the agitators, it hints, might profitably occupy themselves with trying to get some clear idea of the problems they are so eager to attack. "It would be useful if they would employ their leisure in framing a definition of a living wage a little more precise and intelligible than any they have yet vouchsafed. When they have settled what is a living wage for a miner, perhaps they will try to determine what is a fair day's work, or otherwise will kindly explain where the living wage is to come from in the event of the day's work not being worth it. They would also add greatly to their usefulness and avoid some rather ridiculous declamation if they would master the elementary truths that what are called economic laws are not perverted ethical maxims invented by unchristian economists, but simply generalizations of everyday phenomena. People had been buying in the cheapest market for thousands of years before English economists drew out in formal propositions the consequences of that universal tendency." Before men stand up

to denounce these laws or "doctrines," as they are oddly called, "they ought to understand what they mean, and might even be expected to show that they are never guilty of the unchristian practice of buying in the cheapest market, and so in their degree keeping down wages. Political economy, if these vehement controversialists could only see it, is nothing but common sense and common observation thrown into a methodical and systematized arrangement. If a man has the materials, he need not trouble himself very much about the system. Let the people who demand a living wage in the name of Christianity just begin with an exact inquisition into their own conduct and its consequences. Are they in the habit of paying two guineas for a hat when they can get one as good for thirty shillings? Do they ever knowingly give forty shillings for a ton of coals when they can get coals as good for thirty-five? Of course they do not. Nobody does, but the execrated law of supply and demand is nothing in the world except the working out in the gross of the general habit of getting the best value for one's money. Every one who imagines that he sees a way to get rid of this unchristian law ought to try his panacea on a small scale with his own income. When he is perfectly certain that he uses nothing without being sure that everybody employed in making it has had a living wage, he will be in a better position for lecturing coal-owners. He will also have begun to see that industrial problems can not be settled by invocation of undefined Christian principles."

The Highest Meteorological Station in the World.—The highest meteorological station in the world, before a still higher one was established on El Misti, 19,200 feet, was the Charchani station of the Arequipa Observatory, Peru, a branch of the Harvard College Observatory situated on Charchani Mountain, just below the permanent snow line. As described by Prof. A. Lawrence Rotch, it stands at an elevation of 16,650 feet above the sea, near the brink of a plateau, 3,400 feet below the summit of the mountain. From this brink a precipice drops several hundred feet. Near the louvred shelter in which the instruments are kept a stone hut has been erected, where the person who ascends the mountain to care for the instruments can spend the night, if necessary. The ascent of 8,600 feet from the observatory can be made by mule in about eight hours. Though it is intended to have one of the assistants visit the station each four weeks, regular ascents have not been practicable; consequently, during the year the station has been occupied, only portions of ten months' records have been obtained, and unforeseen stoppages of the self-recording instruments have further reduced the number of complete records to eight. The distance in an air line from the station to the observatory is about eleven miles, and such is the transparency of the air that on a large white disk, which has been placed on the edge of the plateau, a black spot, one inch in diameter, can be seen with the thirteen-inch telescope at the observatory. It has not yet been possible to place instruments on the top of the mountain, though that would be desirable. Two attempts have been made, unsuccessfully, to ascend to that point. The comparatively high temperature and small snowfall on the high mountains of Peru offer opportunities for the establishment of loftier meteorological stations than are afforded by any other country, and the establishment of such a summit station by the Harvard Observatory is the crowning of its remarkable series of stations, extending from Mollendo, on the Pacific coast, along the railroad which crosses the desert of La Joye (4,140 feet), reaching the divide at Vincocaya (14,360 feet), and descending the watershed to Puno, on Lake Titicaca (12,540 feet). Another series, differing little in horizontal distance but relatively greatly separated vertically, for which the observatory at Arequipa and the station on El Misti already furnish steps, would make it possible to obtain data of the greatest value for the study of meteorology.

Anthropology at the University of Michigan.—The first work in anthropology at the University of Michigan was begun in the second semester of the college year 1891–'92, with a course in museum laboratory work in American archæology, under the direction of Prof. F. W. Kelsey. The course was attended by two students. Provision was made for the exhibition of the collections in the possession of the institution, and soon

had to be added to. It was then found that the university had a much more valuable collection than was at first supposed. Among its most interesting and instructive features were a typical lot of about forty neolithic implements from Denmark; stone and pottery specimens illustrating the archæology of Michigan; potsherds and pottery vessels from the islands at the mouth of the Amazon; ancient Peruvian vessels from Ancon and Pacasmayo; pottery vessels from the East Indies; skulls, including some of the perforated crania described by Henry Gillman, so mounted that they may be examined on all sides and measured without handling; stone hammers or mauls from the ancient copper pits at Isle Royale, Mich.; the De Pue collection of implements from the surface of the immediate neighborhood of the university; and casts from the Smithsonian collections, with descriptions. Several prehistoric village sites have been discovered near Ann Arbor, which, it is hoped, may soon be thoroughly examined. A survey has been made of one of the prehistoric "garden beds" at Kalamazoo. As yet the work of the museum has been chiefly confined to archæology, but it is expected that, as the department develops, other phases of anthropological science will be studied.

The Conditions of Rain-making.—The conditions of successful rain-making, as defined by Prof. A. Macfarlane, of the University of Texas, in the light of Mr. John Aitken's experiments on fogs and dust—not in a small portion of the atmosphere cut off from the rest by means of an air-tight receiver, but on a large scale in the unbounded atmosphere—are: "If the air operated on is at a temperature higher than its temperature of saturation, it must be cooled down to that temperature. Further, when the moisture condenses it gives out latent heat, which tends to arrest the process; this latent heat must be removed. It is not, as some rain-makers have imagined, 'Pull a trigger; Nature will do the rest.' The only trigger-pulling which experiments warrant as possible consists in supplying the necessary fine dust for nuclei, so that condensation may take place without delay when the air is cooled to its temperature of saturation; or in supplying fine dust from such a substance as common salt, which has a chemical affinity for water and may be able to accelerate slightly the falling of a shower. Suppose we take a cubic mile of the air upon which Dyrenfurth operated on the night of Friday, November 25, 1892. The record at the weather office in San Antonio, at 8 P.M., gave the temperature of the air as 72° Fahr., and the dew point as 61° Fahr. To cool down a cubic mile of that air to the dew point would require the abstraction of as much heat as would raise eighty thousand tons of water from the freezing point to the boiling point. To cool it down another eleven degrees would require as much more heat to be abstracted. The amount of water set free would be twenty thousand tons, which, spread over a square mile, would give about 1·4 pound per square foot, or $\frac{7}{1000}$ of an inch of rainfall. The amount of latent heat set free by the condensation of that amount of water would raise one hundred thousand tons of water from the freezing point to the boiling point; and it would be necessary to absorb this heat in order that the rain-making might go on. I have supposed the cubic mile of air to be kept constant; if the air operated on is constantly changing, the task becomes one of infinitely greater difficulty." It is hardly necessary to say that Prof. Macfarlane considers the professional rain-makers, the proceedings and pretensions of eight of whom he reviews in his paper, as "no better than the medicine men of the Indians."

Anomalies in Weight.—The anomalies in weight at different points on the surface of the earth, which have been recognized for a considerable time, have been attributed to corresponding anomalies in the figure of the earth; to the insufficiency of the formulas for reduction to sea-level; to the unequal distribution of masses; or to inexact observation. A study of the subject by the French commander Defforges, which included forty-one observations at twenty-five stations of different latitudes and elevations, shows that weight is distributed very unequally over the globe; that Clairaut's law, true as a whole, is nearly always marked by notable anomalies; that weight, on the shores of different seas, presents feeble anomalies, constant, and consequently characteristic, on

the same shore; that a considerable excess of weight prevails in islands; that the rule is inverse on the continents, and the deficiency seems to increase in proportion to the altitude and the distance from the sea; that anomalies in weight, positive in Spitzbergen, Scotland, and Corsica, become negative in continental France and Algeria; that continental anomalies increase with the altitude and the distance from the sea; that anomalies in weight can not be attributed to anomalies in the shape of the earth, and the explanation of the irregularities must be asked of geology; and that these results are confirmed by comparing Anglo-Indian and French measurements.

Relations of Floras and Geological Formations.—It is generally recognized that certain floras and certain geological formations go together; and the plants are spoken of as characteristic of the formation. One of the best recognized of these characteristic floras is that of the pine barrens of New Jersey, which was observed several years ago to extend northward into Staten Island and Long Island. In these places the flora growing upon the cretaceous and that growing upon the drift are so distinct that the fact could hardly fail to attract the attention even of the superficial observer. More recently many characteristic species of this pine-barren flora have been recognized as growing in southern Rhode Island, on Block Island, near New Bedford, Mass., on Martha's Vineyard, and Nantucket, and even as far north as Canada. The question arises, How did it spread to the places in New England where it is now found? It is a southern flora, and is characteristically American. Its course of migration was from the south, either by way of the mainland through New York and Connecticut, or else across the salt water from Long Island. The subject has been studied in the light of the geology and topography by Mr. Arthur Hollick, who concludes that there was during a considerable period of time a continuous strip of land, except for the river outlets, "all the way from New Jersey to Massachusetts, separated from the mainland by a body of water occupying the trough scooped out by the glacier, which, in its present depressed and widened condition, we now call Long Island Sound, but which was then a fresh-water lake or broad river." Afterward the land underwent oscillations in level, in the course of which the glacial moraine was eaten away in places by the sea, and the present series of islands and shoals was formed.

Morals and the Nervous System.—One case of agreement between the practical wisdom of the Bible and the results arrived at by modern science was recently made the basis of a sermon by Rev. G. R. Dodson, of Alameda, Cal. Mr. Dodson described the passage of a current of nervous energy through some portion of the nervous system as being a part of every action of thinking or willing. When we think about doing something, for instance, there is a comparatively faint excitation of the nervous system; a stronger impulse causes the act to be done. Thought and feeling are thus actions which do not get beyond the limits of our own bodies. "How this re-enforces," says Mr. Dodson, "the teaching of Jesus, that not the overt act alone constitutes the crime, but that the sin is committed when the desire is cherished in the heart! Indeed, the desire is the action incomplete, restrained within the limits of the body. In I John, iii, 15, it is said, 'He that hateth his brother is a murderer.' This is physiologically true; hate is murder on the way. Lust is adultery begun." Another important relation between morals and the nervous system is that repetition makes any action easier. The nerve currents meet with considerable resistance at first, but, by repeatedly going over the same paths, they "hew out" and "widen" the ways, so to speak, until they become lines of small resistance and the actions become easy. From the close connection between thinking about an action and directing the body in the performance of it, there comes a surprising result. To be ever thinking of doing anything is to be always beginning to do it. The continual use of the nervous system in thinking of some evil deed is really practicing the deed itself—is making more pervious to the nerve currents the nerve paths which would be used in the performance of the action. Thus it is that some time, when off guard, the temptation (the physiological stimulus) comes, a surplus of nervous energy is discharged along these

lines of least resistance, and the deed is done. In this way many young people, who were supposed to be the models of moral perfection, have, to their own surprise as well as that of their friends, suddenly fallen. In such cases the evil desire, which had before been kept within the limits of the body, is simply continued and completed in the outward world. With what force come to us the words, "Blessed are the pure in heart"! and, again, "Whatsoever things are true, honorable, just, pure, lovely, and of good report, whatever is praiseworthy and virtuous, *think on these things.*" Physiological psychology gives the strongest emphasis to these old moral precepts. Nerve paths used constantly in true thinking and noble sentiment become the lines of least resistance, while those for ignoble thought and feeling become like unused, neglected roads —difficult to travel. It thus becomes constitutionally easy to live nobly, and organically difficult to do wrong. In the second place, when evil thoughts are aroused they are at once automatically negatived (inhibited) by good impulses, and without any action of the will there is an instinctive recoil from the evil suggestion.

Bacteriology and Public Health.—In connection with the relation between bacteriology and public health, Prof. Frankland referred, in the discussion in the British Association, to investigations by himself and others on the purification of drinking waters by subsidence, filtration, and precipitation. He pointed out that great misconception prevailed as to the real value of water analyses, the object of which was to show whether a water was liable to become a source of danger at any time, and not whether it was actually dangerous at a particular moment. Recent methods had, however, made it possible to detect the special bacteria of typhoid and cholera when present in a drinking water. Contrary to the common belief, bacteria could retain their vitality in ordinary water for weeks, while the spores were not destroyed for months; but different species varied in this respect. Sewage was best treated by intermittent filtration through soil. This process removed the bacteria more rapidly and completely than it removed dissolved organic matter. Later investigations had confirmed the early observations of Downes and Blount on the susceptibility of bacteria to the action of light, and it appeared that the well-known disinfecting power of the sun's rays was due to the fact that they actually destroyed bacteria and their spores, the rate of destruction depending on the nature of the organism and the condition in which it was placed.

Coal Dust and Explosions.—In a paper on Explosions in Coal Mines, Prof. H. B. Dixon said that the statement that explosions do not travel through damp parts of a mine has been confirmed, and that it is practicable to localize and isolate explosions by always keeping certain sections of the mine damp. Recent experiments by Mr. Hall and by an Austrian committee agree with some earlier experiments in showing that different coal dusts vary enormously in their degree of inflammability, and that mixtures of some dusts with air are violently explosive if ignited by means of a large flame. The great variation in the properties of coal dusts probably accounts for the difference between the reports from different districts. Whether it is true that coal dust and air alone are explosive, or that the presence of small quantities of fire damp is essential, must be shown by further investigations on the nature of the dust from different mines, the degree of danger attaching to the use of different explosives, and the efficiency of various methods of laying the dust in mines.

Education and "Short Cuts to Utopia."—The question whether the general education of the masses is on the whole a good thing is under discussion in the English papers. A writer in one of them attributes to it "that wonderful readiness to believe in short cuts to Utopia" which is one of the marked and unmistakable features of our day. The Spectator disputes this, and cites the evidence of history as being all the other way. "The most desperate attempt ever made to realize heaven on earth by a short cut was made by the followers of John of Leyden, who were for the most part as devoid of what is now called education as the beasts of the field. There never was such a dream of the short cut to Utopia as was

dreamed at the beginning of the French Revolution; and the agents of that revolution were for the most part peasants and artisans entirely innocent of book learning, who, even in Paris, were accustomed to have their wild newspapers read to them; . . . it was before her people were educated that Prussia conceded the agrarian law on which her state has ever since been organized, and which her people certainly regarded as their short cut to happiness. On the other hand, the effect of John Knox's system of education in Scotland has been to make the country north of the Tweed for two hundred years singularly averse to social dreams; while the Prussians, educated for seventy years—two clear generations—have been the gravest and most sensible and self-sacrificing people of the continent. We question if, even in England, the people are half as dreamy as they were in 1830, when they were profoundly ignorant, or if the French working class, socialist as it is, is half as confident of Utopia as it was forty-five years ago. The American school system, which extends everywhere, has produced a race whose special characteristic is sense so hard that they bear the most provoking evidence of the tendency of wealth to accumulate in few hands without interfering, and shoot down the uneducated foreigners who form the strength of their anarchist party with a decision which, at all events, is far removed from dreaminess."

NOTES.

An interesting study is published by J. Walter Fewkes of the legend of the destruction of the Tusayan pueblo of Awátobi current among the Hopi Indians, and of his researches on the site of the pueblo for the illustration and verification of the story. The destruction was effected by the Hopis about the beginning of the eighteenth century. The investigation was carried on in connection with the Hemenney Southwestern Archæological Expedition.

Vertical writing, which was described and illustrated in the November Popular Science Monthly, has already gained a foothold in Canada, and is attracting considerable attention in the United States. The Educational Review (St. John, N. B.) states that Mr. A. F. Newlands, supervisor of penmanship in the public schools of Kingston, Ontario, introduced it into the schools of that town a year ago. It is also taught and favored in many schools of Montreal and Toronto. It has been given the preference in the public-school system of Nova Scotia, having entirely displaced sloping writing in Halifax. It is also taught in the Halifax Ladies' College. Among the librarians of the United States it is no new thing, having been adopted several years ago by many of them for writing catalogue cards on account of its superior legibility.

Darwin appears, from a communication in Nature by Mr. Kumusagu Minakata, to have been anticipated more than a thousand years in announcing the theory of the adaptation of the color of animals to that of their surroundings, by Twang-Ching-Shih, a Chinese philosopher of the ninth century, who, having described the habits of the trap-door spider (or "tumbling defender") and observed that the lid of its nest is colored like the ground, adds: "In general, birds and animals necessarily conceal forms and shadows by their assimilation with various objects. Consequently, a snake's color is similar to that of the ground, the hare in the imperator grass is unavoidably overlooked, and the hawk's hue agrees with that of the trees."

An ingenious device has been contrived by Dr. A. Cancani, of Italy, for registering the precise time when an earthquake shock occurs. The seismograph is so arranged as to take an instantaneous photograph of the face of a chronometer at the instant of the shock. An adjustment of levers and batteries and magnet is thrown into gear by the shock, so that an incandescent electric lamp is lighted automatically for about a quarter of a second, while the image of the clock is established upon the photographic plate.

An investigation has been made by H. M. Bernard of the comparative morphology of spiders, the results of which he hopes shortly to have ready for publication. These results, he represents, "go far to establish that classification which ranks the arachnids as an independent group of the tracheate arthropods, as distinguished from that which would deduce them from the specialized crustacean *Limulus* through the specialized arachnid *Scorpio*."

The disappearance is reported of the voles or field mice which infested the farms of Scotland a year or two ago to such an extent that the evil they wrought and threatened became a serious economical problem. They were first observed a few years before 1890; multiplied rapidly till the summer of 1892, when they began to decrease, and ceased to be formidable in the summer of 1893. On some farms the normal numbers remain, but on others hardly one is to be seen. The disappearance appears to be general over the whole country. Various causes

have been suggested for their vanishing, among the chief of which the farmers and shepherds name the work of such natural enemies as the owl, kestrel, rook, blackhead gull, buzzard, stoat, and weasel—animals which foolish man is industriously trying to exterminate.

ACCORDING to Meehan's Monthly, the large majority of plants are scentless, and probably not one tenth of the hundred thousand flowering plants known to botanists are odorous. Of the fifty known species of the mignonette family, only the one so highly prized in our gardens is fragrant, and only about a dozen of the one hundred species of violet are scented. In many large genera the scentless varieties are as one hundred to one, and sweet-smelling varieties are comparatively rare among our wild flowers.

IT was observed by the late Mr. Wollaston that most insects inhabiting the Atlantic islands are either strongly winged or incapable of flight. The explanation of the phenomenon is found in the fact that insects exposed to gales are very liable to be blown out to sea. Hence it is almost equally to their advantage either to be gifted with strong enough powers of flight to be able to make their way back when they have been blown away, or never to fly at all, and thus escape the risk of being blown away.

OBITUARY NOTES.

PROF. HEINRICH R. HERTZ, of the University of Bonn, who won fame by his demonstration of the intimate connection of light and electricity, died at Bonn, on New-Year's day, of blood poisoning induced by a chronic disease of the nose. He was born at Hamburg on the 22d of February, 1857; entered the Engineering School in 1875; afterward devoted himself to physics, studying in Munich and Berlin; became an assistant to Helmholtz in 1878; settled in Kiel in 1883 as a *privat docent* in theoretical physics; was appointed in 1885 Professor of Physics in the technical Hofschule in Carlsruhe; and in 1885 succeeded Clausius as Professor of Physics at Bonn. The apparatus with which he made his famous demonstration was shown at the Electrotechnic Exhibition at Hamburg, where it attracted much attention, particularly from men of science. His own account of his demonstration of the identity of light and electricity was published in volume XXXVIII of The Popular Science Monthly, December, 1890. We hope, at some future time, to publish a biographical sketch and portrait of him.

THE distinguished Belgian zoölogist, Prof. Pierre Joseph van Beneden, of the University of Louvain, died in that city, January 8th, in the eighty-fifth year of his age. His first scientific position was that of keeper of the Natural History Collections at Louvain. In 1835 he was made an assistant professor at the University of Ghent, and in the same year professor in the Catholic University of Louvain. He was author of a large number of zoölogical and biological papers, particularly on parasites, worms, etc.; joint author with Du Mortier of the Natural History of the Fresh-water Polyzoa, and with Paul Gervaise of the Zoologie Médicale; and author of Recherches sur le Faune littorale de Belgique, and of the book on Animal Parasites and Messmates in the International Scientific Series. He had artistic skill, and contributed illustrations to his works.

PROF. ARTHUR MILNES MARSHALL, of Owens College, Manchester, was killed, December 31, 1893, by a fall on the peak of Scafell, Cumberlandshire, England. He was born in 1852; entered St. John's College, Cambridge, in 1871, where he was one of the earliest students in the school of biology, and whence he was graduated on completing the course; entered upon the study of medicine at St. Bartholomew's Hospital in 1876; and was appointed Professor of Zoölogy in Owens College in 1879. He was author of a series of papers on the Cranial Nerves, on the Pennatulidæ, and on the Nervous System of Antedon, and of works on Vertebrate Embryology, the Frog, and Practical Zoölogy; was secretary and afterward chairman of the board of studies of Victoria University; was a Fellow of the Royal Society; and was an active worker in the university extension movement. He had ascended the mountain with a party on the day of his death, and was standing at a point higher than the others, when a rock fell, carrying him with it.

THE eminent zoölogist and paleontologist, Dr. Paul Henri Fischer, who died in Paris, November 29, 1893, was born in Paris in 1835; became Demonstrator of Paleontology in the Museum of Natural History of Paris in 1861; and rose to be assistant naturalist there. From 1856 he edited the Journal de Conchyliologie in collaboration with M. Crosse. He studied very successfully the marine animals of the coast of France and their geographical and bathymetric distribution. He and the Marquis de Folin, examining the Fosse du Cap Breton in the Gulf of Gascony, discovered a large number of forms previously unknown, some of which resembled fossil forms. With M. Delesse he made researches on the submarine sediments of the French shores. He took part in the expeditions of the Travailleur and the Talisman. His works, books, pamphlets, and memoirs include three hundred titles.

THE death, at Kiel, in November, 1893, is reported of Baron von Bulow, founder of the Bothkamp Observatory, the first observatory in Germany devoted to astro-physical researches.

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* * *

The Memoirs of the Baron de Meneval, to be published shortly in France, England, and America, furnishes a picture of Napoleon's daily life which is believed to be unexcelled in point of closeness of observation and graphic detail by any other narrative. The basis of this statement will be understood by those who remember the relation of the Baron de Meneval to Napoleon as his private secretary, and necessarily in large degree his confidant. The memoirs of Napoleon's other secretary, De Bourrienne, has been well known in Napoleonic literature for two generations, and yet his opportunities were less than those of Meneval, his powers of observation no more keen, and his accuracy, judging by internal evidence, is less to be relied upon. Nevertheless, while De Bourrienne's book has become almost a classic, Meneval has been classed rather as the biographer of Marie-Louise. For a time he seemed absorbed in his duties to the deposed empress, and, curiously enough, the literary monument which he had erected at the time of his death bore the name of the empress, not that of his great master. That work was published about 1840. Meneval's smaller book dealt only with a phase of the Napoleonic cycle. That he was not the man to neglect his opportunities is shown abundantly by the glimpses of character revealed in his books; that his diaries and notes contained most valuable material is made clear by the forthcoming volumes of his memoirs. Yet, for personal and other reasons, his invaluable recollections were not given to the world. They have been treasured by his family until the present time of profound interest in Napoleonic history, and, in France perhaps, equally profound desire to develop as concretely as possible the Napoleonic idea.

. . . . .

It is the grandson of the Baron de Meneval whose privilege it has been at last to present to the world these fascinating pictures of Napoleon's daily life. The manuscript memoirs left by his ancestor have been intelligently prepared for the press, and the publication,

awaited with deep interest by those who have learned of the existence of this work, is now close at hand.

The Baron de Meneval was forced by the Revolution to leave the Collége Mazarin without any special profession in view. Certain literary efforts brought him the acquaintance of Palisset, whom he characterizes as the dean of the Parisian literary guild, and at his house he met Louis Bonaparte, the brother of the already distinguished general. After an interval which is filled in Meneval's memoirs with an explanation of the manner of Napoleon's recall from Egypt and an account of the signing of the treaty with the United States, we reach the date of March, 1802, when Meneval's friend Joseph Bonaparte informs him that the first consul desires to see him and to attach him to himself, and that he is dissatisfied with De Bourrienne. The arrangement was made briefly and unceremoniously. Meneval's first introduction to his duties was equally unceremonious. Napoleon entered abruptly, carrying a memorandum. "He dictated to me a note for the Minister of Finance with such a volubility that I could hardly comprehend and write half his dictation. Without asking if I had understood it and had finished writing, he took the paper from my hands and did not permit me even to read it over. When I exclaimed that it was an illegible scrawl, he started for the other room, replying that it was a matter familiar to the minister and that he would make it out. I have never known whether M. Gaudrin was able to decipher my writing." This was Meneval's introduction to the rapidity of Napoleon's methods. There was none of the usual formality and delay of bureaucracy. . . .

Meneval pictures Napoleon's personality at this time as follows: "He was moderately stout, but grew portly later, owing to his frequent bathing in hot water. He was of medium height and well-proportioned, although his body was a little long. He had a large head and well-developed cranium. His neck was short, and his shoulders broad. The depth of his chest showed a robust constitution, less strong, however, than his will. He had a well-turned leg, a small and well-shaped foot. His hand, in which he took a certain pride, was delicate and plump, with tapering fingers. He had a high, broad forehead, and penetrating and singularly restless eyes. The nose was straight and well made, the teeth good, the mouth perfectly modeled, the upper lip slightly drawn down toward the corners of the mouth, the chin somewhat prominent. His skin was smooth, and his complexion pale but not bloodless. His auburn and very fine hair, which he had worn long, cut straight, and covering his ears up to the time of his Egyptian expedition, was cut short. The hair was scanty, thin on the upper part of his head, and disclosed his forehead, a seat of lofty thoughts. The contour of his face and his features were of a remarkable regularity. Finally, his head and bust did not yield, in nobility and dignity, to the most beautiful busts that antiquity has bequeathed to us. . . . When he was excited by some violent passion his face assumed a severe and even terrible expression. . . . As a rule, his face was calm, meditative, and serious, but gracious. His smile was most charming, and his whole face bore a fairly caressing expression when he was in good humor or desired to please. In familiar intercourse he was given to noisy laughter and raillery." . . .

Up to 1814 Meneval remained Napoleon's confidential secretary, in daily intercourse with him whenever he was in Paris.

No opportunity was lacking for an acquaintance with Napoleon's personality, and a knowledge of his methods and habits and modes of thought—knowledge which is invaluable in these memoirs, not only from its immediate interest as portraiture but also from its

value in elucidating many disputed matters of history with which Meneval had to deal. Of all this we can say nothing in this brief announcement, which is simply a characterization of the intimate interest and historical consequence of this work. Up to 1815 Meneval lived either in direct contact with Napoleon or in communication with him by letter. Meneval was a man of the pen, not of the sword, but since he was sitting at the fountain-head of information, he is able to shed new light on many features of the Napoleonic campaigns. This constitutes necessarily a secondary feature in his work. Of Napoleon's relations with Josephine and Marie Louise—of all the features of his domestic and social existence—Meneval had abundant knowledge, for he shared Napoleon's private life. His narrative, it need not be said, is most interesting. Its historical importance need not be emphasized.

* * *

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* * *

Teachers who heard or read George H. Martin's paper on the Public Schools of Massachusetts, and followed the controversy that ensued between him and ex-State Superintendent Draper, of New York, in the *Educational Review* last year, will be interested to learn that Mr. Martin has prepared a volume comprising the substance of these essays, soon to be published as one of the International Education Series, under the following title: *Evolution of the Public-School System in Massachusetts.* It will be an interesting contribution to the history of pedagogy.

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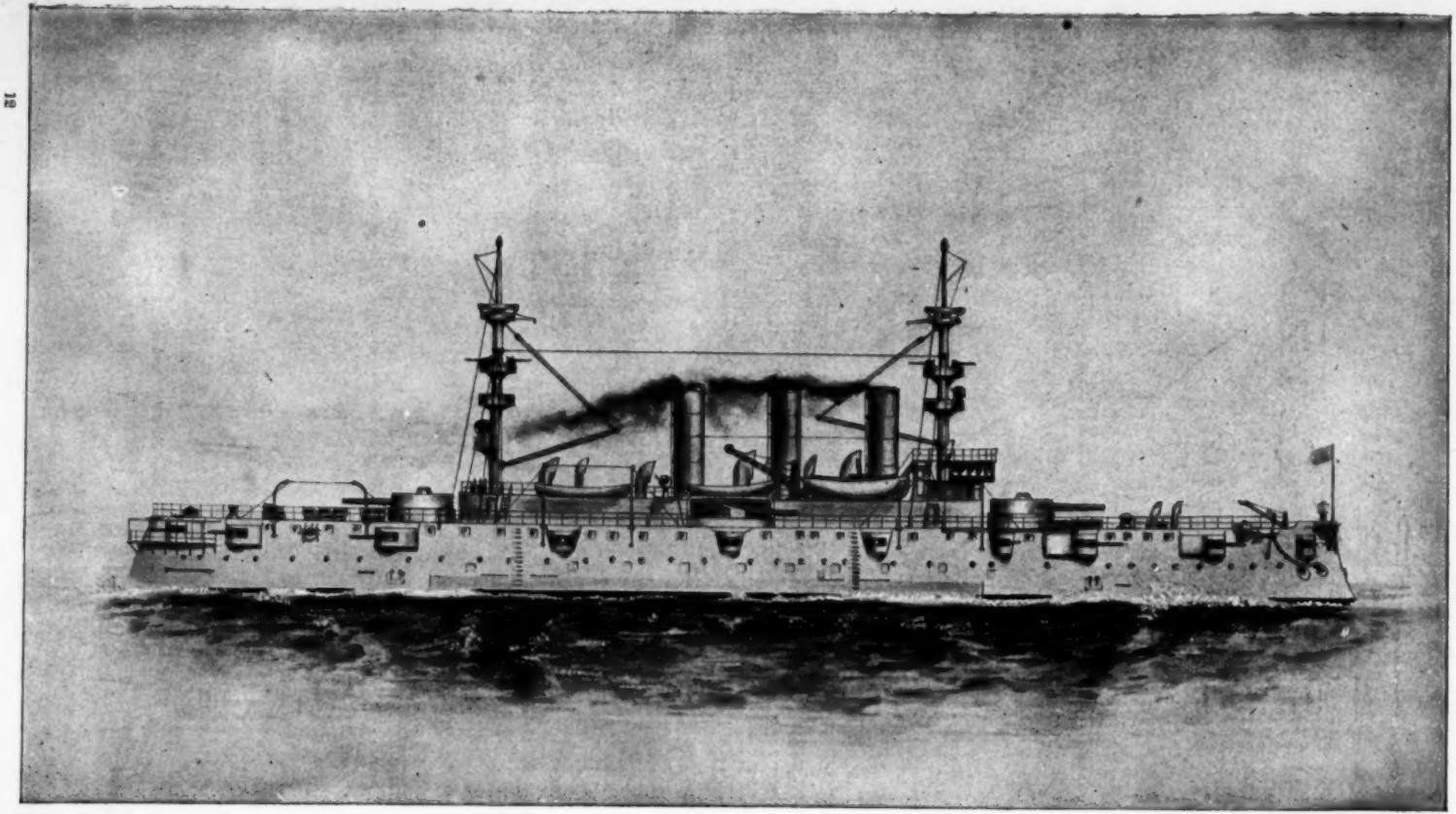

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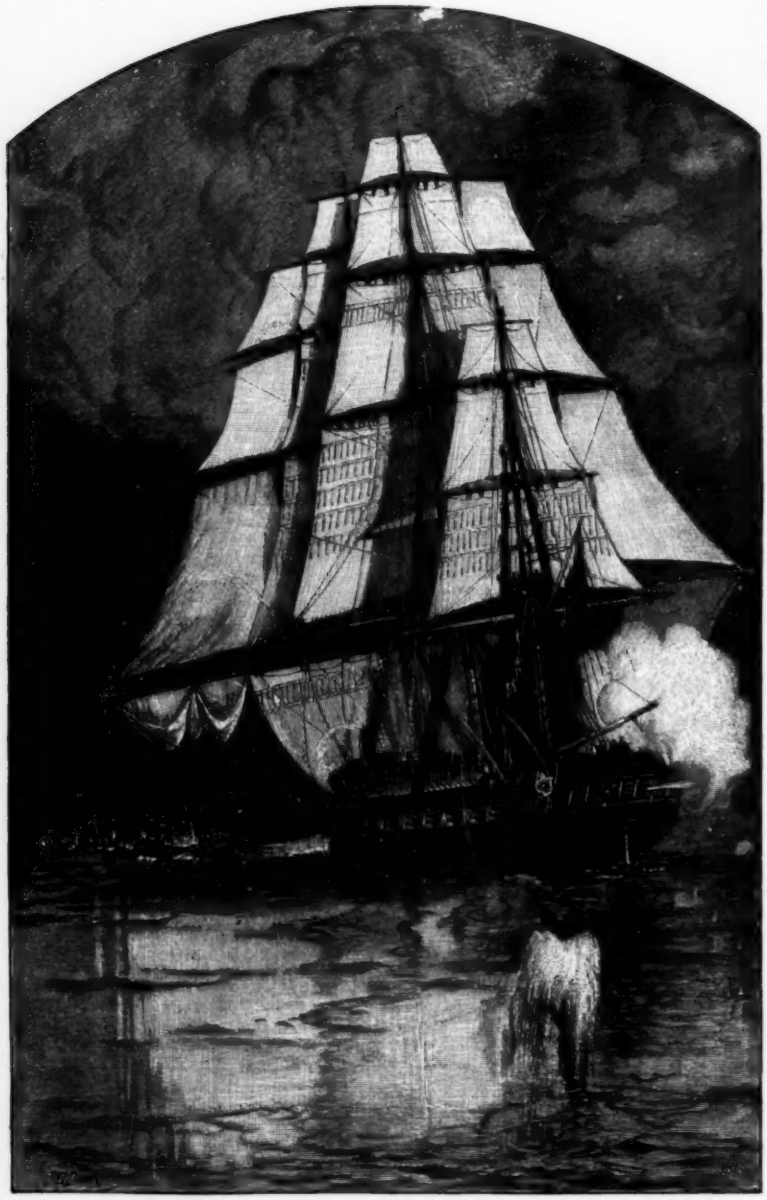

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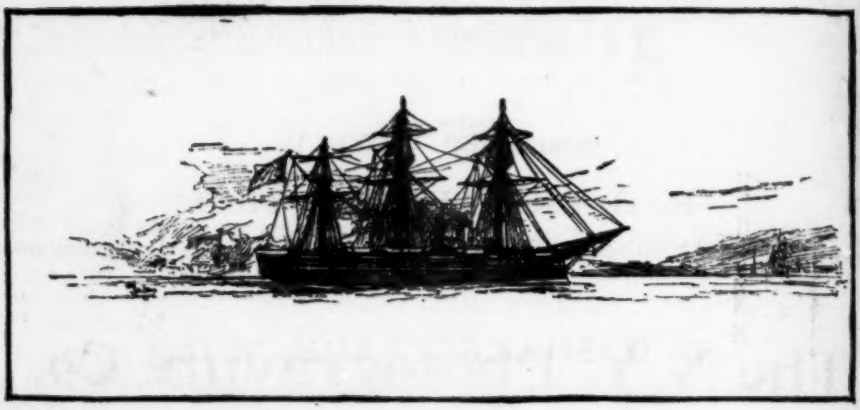

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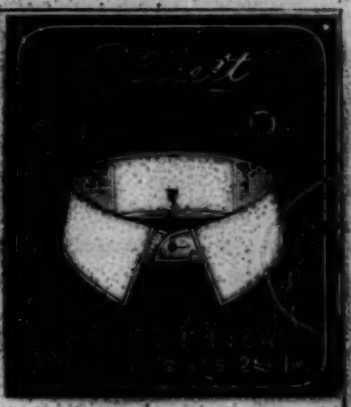

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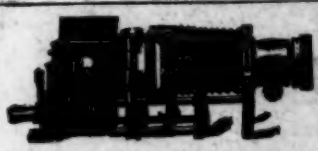

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Yours truly,
DR. HANS VON BÜLOW.

Hamburg, 27th May, 1890.

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TO
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JANUARY 1, 1894.

ASSETS.

Real Estate, including 11 Office Buildings and 85 pieces of property purchased under foreclosure	$13,139,049 93	
Stocks and Bonds owned (market value)	89,998,636 45	
Bonds and Mortgages	25,805,235 20	
Loans secured by collaterals (market value of Securities held as collateral, $3,349,425 67)	2,428,966 67	
Premium Loans on existing Policies (the reserve on these Policies, included in Liabilities, amounts to over $8,000,000)	3,737,881 71	
Cash in Office and in Banks and Trust Companies	7,012,468 93	
Interest and Rents due and accrued	1,455,008 02	
Net Amount of uncollected and deferred Premiums	5,108,834 30	
TOTAL ASSETS		**$148,700,781 21**

LIABILITIES.

Reserve on outstanding Policies, at Actuaries' 4 per cent as per Certificate of New York State Insurance Department, including Additional Reserve on Annuities and Accumulation Policies voluntarily set aside by the Company	$129,882,448 00	
Losses awaiting proof or payment	1,330,854 37	
Matured Endowments due and unpaid (claims not presented)	122,007 76	
Annuities due and unpaid (claims not presented)	22,770 00	
Unpaid Dividends due Policy-holders	134,533 64	
Premiums paid in advance	134,554 82	
Trust Deposit, held for account of beneficiaries under terms of Policies	67,982 42	
Total Liabilities		**$131,675,151 03**
Net Surplus per Certificate of Insurance Department		**$17,025,630 18**

INCOME.

Premium Receipts	$27,488,657 44	
Interest, Rents, etc.	6,374,989 51	
Total		**$33,863,646 95**

DISBURSEMENTS.

Death Claims paid	$8,440,093 46	
Endowments matured and discounted, paid	1,083,445 95	
Annuities paid	1,407,256 95	
Dividends paid	1,744,391 76	
Paid for Purchased Policies	2,339,062 13	
Installment paid on Trust Deposit	4,200 00	
Total amount paid to Policy-holders	$15,018,450 27	
Commissions, Brokerages, and Payments to Agents	4,579,880 89	
Agency Expenses	1,079,342 28	
Physicians' Fees, Advertising, and Rent	383,167 96	
Salaries to Officers and Employees	763,469 30	
Law and Office Expenses, Stationery and Printing, Traveling and other Expenses	761,117 92	
Taxes in the State of New York and other States	317,296 97	
Total Disbursements		**$23,424,725 21**

INSURANCE ACCOUNT.

	No.	Amount
New Policies issued in 1893 (Declined, 10,305, $28,569,737)	85,568	* $223,848,991 00
In Force December 31, 1892	324,008	869,248,629 00
In Force December 31, 1893	361,992	779,156,672 00
Gain in 1893	37,984	$89,908,043 00

* Net including policies revived, paid-ups, or reversionary additions.

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